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POSTER ABSTRACTS

Water loss modulates skin chilling expression in Hass avocado fruit

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Skin chilling damage can be a major risk for 'Hass' avocado fruit when storage life has to be prolonged by refrigeration, as when exported by sea. The occurrence of the characteristic dark patches, termed discrete patches (DP), on an otherwise green skin has been suggested to be manageable through controlling water loss. However, this seems difficult to reconcile with the disorder being a chilling injury i.e. induced by a low temperature. The role of water loss in chilling injury was investigated by storing fruit at a constant 3°C for up to 6 weeks, but with three different relative humidity (RH) conditions to manipulate water loss. The findings suggest that water loss is more a modulating factor in the expression of the symptoms rather than any fundamental controlling factor. Under a low RH, the DP were more apparent earlier and at a greater severity than on fruit at the same temperature but under higher RH. It appears that the role of water loss in the expression of skin chilling damage is more one of modulating the rate of symptom expression rather than of initiating symptoms. Therefore, the ability to control the disorder through water loss management may be limited to the severity of symptoms.

Persea, fruit, quality, storage, chilling injury

Ranking the incidence of core-flush in Braeburn apple orchards stores based on ethane and CO_2 efflux

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Braeburn apples stored under Controlled Atmosphere storage suffer on occasion from internal physiological browning disorders notably core-flush and Braeburn Browning Disorder symptoms. These disorders are partly the consequence of poor gas diffusion characteristics of the fruit due to a lack of connectivity of air spaces across the inner and outer cortex to the epidermis. The advent of Dynamic Controlled Atmosphere (DCA) storage allows apples to stored at lower oxygen conditions that can help delay the onset on internal browning disorders. However, it is necessary for growers to identify orchard consignments that have a greater propensity to develop internal physiological disorders to allow these can be marketed early, allowing fruit with a lower potential risk to be stored in long-term DCA- stores. The use of gas diffusion tests as a metric for fruit porosity have been previously reported. Ethane and CO_2 efflux techniques normally require Gas Chromatography to measure gas efflux accurately. We report the use of CO_2 measuring devices such as Micropods and Labpod-mini: (SCS Inc) to record in real-time the efflux of CO_2 from consignments of Braeburn from commercial orchards and cross relate porosity characteristics with ethane efflux measurements. We explore the potential to relate gas efflux with the incidence of internal browning disorders in Braeburn in years of higher risk.

Braeburn, core-flush, ethane, CO_2 efflux

No soft scald in ‘Red Aroma’ apple fruit: mission possible?

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Soft scald is a physiological chilling disorder occurring during storage, with a range in susceptibility between apple cultivars. Experiences from different countries and cultivars have shown that delayed cooling and storage at higher temperatures (3°C to 4°C) can alleviate soft scald development. However, both strategies reduce the potential shelf life. The main apple cultivar grown in Norway, 'Red Aroma,' is particularly susceptible to soft scald and rapid firmness loss during storage, making common strategies for soft scald control impractical. Optimised strategies for both maintaining firmness and minimizing soft scald incidence during storage were tested during several seasons. The results regarding firmness maintenance and reducing the rate of postharvest ripening were distinct and as expected for all treatments tested. Soft scald incidence differed more with orchard origin and seasonal differences than with the treatments. Ways of evaluating potential soft scald risk related to preharvest stresses are discussed.

Malus domestica var. Borkh, fruit quality, controlled atmosphere storage, 1-MCP

Lenticel spots - primary and secondary causes

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Apple fruit develops over a period of up to six months from bloom to harvest. The fruit development can be affected in a variety of ways, both positively and negatively, by weather conditions. Lenticels form and expand during fruit development and are vulnerable to mechanical or physiological damage, acting as entry points for pathogens. Fruit with dark coloured rot spots in the lenticels have been noticed in some seasons in Norway, but only investigated systematically in 'Red Aroma'. Fungal isolations were performed at harvest, after incubation, and after storage with the aim of identifying the causal agent of small fruit rot spots in the lenticels. Numerous isolations resulted in a range of pathogens, but were consistently dominated by a *Phoma sp.* irrespective of growing region or year. Inoculation experiments, both with detached fruit and on fruit trees, did not produce significant disease symptoms indicating that the isolated *Phoma sp.* is not pathogenic. Similar symptoms have been previously hypothesised to result from weakened lenticels caused by different climatic conditions. Thus, there is a need to further investigate the causes of weakened lenticels on different cultivars and their susceptibility to pathogenic and physiological damage. Possible factors include weather conditions in a Northern climate, growing season and orchard variability, and differential cultivar susceptibility.

Weather conditions, lenticel disorders, rot spot

Postharvest storage temperatures prior to CA storage affect susceptibility of ‘Empire’ and ‘McIntosh’ apples to carbon dioxide injury

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External carbon dioxide injury, manifested by epidermal discolouration, is a physiological disorder that affects many apple cultivars. The disorder is a major concern for 'Empire' and 'McIntosh', two cultivars of economic importance in the northeastern USA. Postharvest 1-MCP treatment increases susceptibility of the fruit to injury, in part because it maintains sensitivity of the fruit to carbon dioxide levels in the storage. Currently, external (and internal) carbon dioxide injury is controlled by the application of the antioxidant diphenylamine (DPA), but continued concern about the future availability of DPA, has resulted in investigation of factors that affect susceptibility of fruit to the disorder. In this study we have kept 'Empire' and 'McIntosh' fruit either untreated or treated with 1-MCP at 2 °C or 7 °C for 2, 7 or 14 days, cooled all fruit to 2°C overnight at each delay time, and applied CA storage regimes. Injury incidence of 'Empire' apples without 1-MCP treatment was negligible in fruit from all delay treatments. For 1-MCP treated fruit, a small incidence was found in fruit maintained at 2°C before CA storage, but in the 7°C pretreatment, the susceptibility of the fruit to injury increased dramatically with increasing number of days. Injury incidence was 6%, 20% and 36% for fruit kept at 7°C for 2, 7 and 14 days, respectively. Overall injury in the 'McIntosh' fruit was lower but an effect of pretreatment time was also found. These results point to pre-storage temperatures as an important factor, especially for 1-MCP treated fruit in the absence of DPA.

Malus domestica, physiological storage disorders, temperature, CA storage

Watercore in Eden

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Watercore, regardless of cause, is relatively uncommon in the cool climate of Norway. Externally visible stress watercore has been noticed sporadically, but has not been considered an issue of commercial importance. In addition to cool weather limiting occurrence of the disorder, it is likely that most commercially grown cultivars in Norway have limited susceptibility to watercore. However, in the 2022 season up to 20% watercore at harvest and 4% watercore breakdown in storage was observed in a newly released cultivar, 'Wursixo', marketed as 'Eden' in Norway. In the 2023 season, fruit of 'Wursixo' from different locations and different growers was assessed for watercore. At harvest, up to 23% watercore was observed, while up to 15% watercore breakdown was found after storage of seven weeks. Observations from two seasons in a row on fruit from locations with different weather conditions indicate that 'Wursixo' is more susceptible to watercore than the more commonly grown cultivars in Norway. One of its parents, 'SQ159', has in practice been noted as susceptible to watercore. In the 2023 season, there was a range in severity of watercore at harvest and dissipation occurred in fruit with slight incidence during six weeks of storage. However, in fruit with severe watercore, watercore breakdown was already found after two to three weeks of storage. Current marketing plans rely on selling the fruit between two to four weeks after harvest. The rapid development and severity of watercore breakdown underlines the need for further investigation of the phenomenon in this new cultivar to avoid consumer complaints or future marketing issues.

Malus domestica Borkh., Wursixo, watercore breakdown, dissipation, orchard variability

Oxidative pinking discolouration of leaves of different positions of lettuce head

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Pinking discolouration reduces lettuce quality and consumer acceptance. It is believed that the pinking process involves formation of an unidentified pink-coloured compound(s) as products of reactions involving phenylalanine ammonia lyase (PAL) and polyphenol oxidase (PPO) in the phenylpropanoid pathway. We propose that leaf maturity and exposure to the environment pre- and post-harvest affects shelf life of fresh-cut vegetables, including pinking discolouration, and related to leaf position relative to its core. We aim to determine the occurrence and biochemistry of pinking in different leaf layers of lettuce during cold storage (5°C). Pinking began to be visible on day 4 of storage. Outer (older) leaves which represented by the 1 st quartile of the leaves showed a significantly higher degree of pinking compared to the inner (younger) leaves. However, PAL and PPO activity did not show a significant relationship with pinking. PAL activity was found to be the highest at day 6 of storage, though it was followed by decrease at day 8 which supported previous findings. Both PAL and PPO activity were the highest for the inner most leaf layer (4 th quartile). Results of HPLC-DAD analysis showed that chlorogenic acid was the most abundant phenolic acid detected. A 2-fold increase in chlorogenic acid and caffeic acid were observed in outer, mature leaves of Romaine during storage, corresponding with a proposed phenylpropanoid pathway from previous research on pinking. In summary, pinking was highly associated with chlorogenic acid, caffeic acid, and coumaric acid but negatively associated with PPO activity.

Lactuca sativa, pinking, phenolic acids, PAL, PPO

Underlying mechanism of a postharvest deformation, blossom end-enlargement in cucumber fruits

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The underlying mechanisms of postharvest deformation of cucumber fruits and blossom-end enlargement (BEE) were investigated using artificial treatment with plant growth regulators. p-chlorophenoxyacetic acid, N-(2-Chloro-4-pyridyl)-N'-phenylurea (CPPU), 6-Benzyladenine, (2-Chloroethyl) phosphonic Acid (ethephon), prohydrojasmon, and gibberellin were applied on the fruits at before or after harvest at some concentration. Only pre-harvest application of CPPU prevented BEE. The finding that fruits with fertilized seeds are more likely to develop BEE than parthenocarpic fruits also supports the possibility that cytokinin concentrations in fruits are involved in the occurrence of BEE. As a result of the expression analysis of hormone-related genes that work under sugar starvation in the mesocarp tissue, no difference in gene expression levels was observed between fruits that developed BEE and those that did not, regardless of whether they were treated with CPPU. Fruits that grow faster and have shorter periods from flowering to harvest are more likely to develop BEE. In contrast, although fruits pre-harvested with CPPU showed a lower occurrence of BEE, they grew faster than untreated fruits and reached harvest within a shorter period of time from flowering. These results suggest that BEE is not directly caused by sugar starvation or the juvenile nature of the fruit but is caused by a temporary lack of cytokinin synthesis in the symptomatic portion or cytokinin influx from other parts at a specific time.

Deformation, cytokinin, sugar starvation, plant growth regulators

PH9

Differential responses of targeted major metabolites to chilling injury-related browning disorders in yellow bell pepper fruit

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Bell pepper fruits are relatively susceptible to various physiological disorders during cold storage. The symptoms of physiological disorders would be resulted from chilling injury (CI) after cold storage. In this study, we focused on the elucidation of targeted major metabolic alteration to the incidence of chilling injury-related browning in the pericarp of 'Volante' yellow bell pepper fruit for shelf life after cold storage. To reveal the metabolic mechanisms associated with CI development, we analysed the comparative responses of targeted major metabolites to chilling injury-related browning tissues (surface browned and pericarp browned tissues) of yellow bell pepper fruit stored at 0.5°C for 2 weeks and then transferred at 22°C and 80% RH for 5 days. In term of fruit quality attributes, pericarp firmness and soluble solids content were higher at harvest than after shelf life following cold storage, but ethylene production and respiration rates were lower at harvest. However, peel colour variables were higher at harvest than after shelf life. The levels of glucose and citric acid were lowest but fumaric acid was highest at pericarp browned tissue, compared with the other tissues. Interestingly, the levels of glutamic acid, tyrosine, leucine, methionine, phenylalanine, and tryptophan were highest at surface browned tissues, but the most amino acids were lowest at pericarp browned tissues, compared with the other tissues. The contents of palmitic and arachidic acids were highest but linoleic and α-linolenic acids were lowest at pericarp browned tissues, compared with the other tissues, thereby contributing to reducing UFA/SFA and double bond index (DBI) ratios. Therefore, the results indicated that the targeted major metabolic alteration could be differentially responded to the incidence of chilling injury-related browning disorders in yellow bell pepper fruit during shelf life after cold storage. (This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through 'Smart Agri Products Flow Storage Technology Development Program' funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA)(grant No. 322052052HD030).)

Amino acids, cold storage, fatty acids, surface browning, paprika fruit, pericarp browning

PH10

Sugarbeet root storage conditions and plant genetics affect sugar transporter gene expression with likely effects on postharvest sucrose losses

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Sugar transporters effect movement of sugars across cellular membranes and play a critical role in relocalizing carbon substrates within cells, tissues, and organs to support their metabolism and response to stress. Sugar transporters are especially important for postharvest sugarbeet roots since the export of sucrose from the vacuole of parenchymal storage cells not only fuels root metabolism but also drives sucrose loss during storage. Despite the obvious importance of sugar transporters to sugarbeet root postharvest metabolism, the identity and expression of sugarbeet root sugar transporters during storage have never been examined. Therefore, the expression of sugar transporters in harvested and stored sugarbeet roots was determined with respect to storage duration and temperature and in genotypes that likely differed in rates of postharvest sucrose utilization due to differences in respiration rate. Highly and differentially expressed sugar transporters largely belonged to the SWEET (sugars will eventually be exported transporter) and TST (tonoplast sugar transporter) families of sugar transporters. Eight SWEET genes and two TST genes were expressed in postharvest sugarbeet roots. The expression of these SWEET and TST genes generally increased with time in storage, but was only minimally affected by storage temperature. SWEET N3 and TST 2.1a were the most highly expressed and upregulated sugar transporter genes during storage. These genes were also differentially expressed in lines with genetic differences in storage respiration rate. Overall, these results highlight the likely importance of SWEET and TST genes for postharvest sugarbeet root metabolism and identify gene candidates that may have roles in storage sucrose loss.

Beta vulgaris, SWEET genes, TST genes, sugar transport

PH11

Transcriptional and enzymatic changes in carbohydrate metabolism in wounded sugarbeet taproots

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Sugarbeet roots incur severe injuries from aggressive harvest and piling operations, and these injuries increase root postharvest respiration rate and the incidence of storage diseases. Increased respiration and induction of root defense mechanisms triggered by both wounding and disease necessitates carbohydrate metabolism to generate carbon substrates and metabolic energy to fuel these processes. To understand how wounding alters sugarbeet root primary carbon metabolism to support respiration and defense responses, the effect of wounding on the transcription and activity of enzymes involved in sucrolytic, glycolytic and TCA cycle pathways were determined during the initial 24 hours after wounding. Wounding caused rapid changes in soluble sugars composition. Invertase and sucrose synthase genes involved in the catabolism of sucrose to its monosaccharides as well as seven genes that contribute to the glycolytic pathway were differentially expressed in wounded roots. Transcriptional changes for glycolytic genes, but not sucrolytic genes, were generally reflected in changes in enzymatic activities. Glycolytic genes and activities for hexokinase, phosphofructokinase, glyceraldehyde-3-phophate dehydrogenase, and pyruvate kinase were of particular note due to their high level of upregulation. Genes for pyruvate decarboxylase and alcohol dehydrogenase that are responsible for the fermentation of pyruvate to ethanol, as well as their enzymes activities were also upregulated in response to wounding. The glycolytic pathway was enhanced by wounding due to activation of seven family genes, leading to significant decrease of glucose content and increase of anaerobic fermentation route.

Beta vulgaris, sugars, postharvest

PH12

Mechanisms involved in the induction of non-climacteric fruit ripening: insights from transcriptomic analysis of *Capsicum annuum*

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Different from ethylene, which is the primary factor inducing climacteric fruit ripening, there are currently multiple theories regarding the mechanisms triggering fruit ripening in non-climacteric fruits. Studies have shown that ABA, soluble solids, ascorbic acid, and citric acid in fruits may be important factors inducing colour changes in various non-climacteric fruits such as chili, sweet peppers, and strawberries. Sweet peppers, as non-climacteric fruits, the colouration of mature fruits on the plant is influenced by sunlight exposure, with light primarily affecting leaf photosynthesis. To understand whether the colour change in sweet peppers is regulated by substances transported from the leaves to the fruits, our experiment showed sweet pepper colouration time is influenced by phloem girdling. The transcriptomic analysis was further conducted to investigate the mechanisms and genes regulating of sweet pepper ripening.

Non-climacteric fruit, girdling, transcriptome

PH13

Volatile compound dynamics and underlying transcriptomics of apple ripening before and after storage

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Climacteric ripening is a highly complex fruit trait that involves massive shifts in fruits' sensing and signaling pathways. This process includes the development of volatile profiles that are associated with the unique and classic flavors of fruits, such as apple. The volatile profile of apple fruit ultimately experienced by consumers is influenced by a variety of factors, including at harvest maturity and postharvest management strategies such as controlled atmosphere. Balancing harvest and postharvest strategies to meet high consumer expectations can be challenging, especially for cultivars requiring specific harvest metrics and long periods of time in postharvest storage to develop desired flavor profiles, such as WA 38, marketed in the USA under the registered trademark Cosmic Crisp®. To improve our understanding of how the flavour profile of WA 38 develops, we sought to identify volatile compounds and characterize volatile compound dynamics during ripening prior to and after air and CA storage of WA 38 apples harvested in North Central Washington, USA. We also used transcriptomics to explore gene regulation changes associated with volatile compound dynamics during ripening.

Volatiles, transcriptome, postharvest, ripening, apple

Changes in internal structure and cell wall polysaccharides of ‘Hakuho’ fruits during ripening

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Peach fruit softening is caused by degradation of homogalacturonan (HG), a cell wall constituent polysaccharide, and endo-polygalacturonase (PG) is thought to play an important role in this process (Yoshioka et al. 2011). On the other hand, Hayama et al. (2000, 2003) reported that expansins are deeply involved in the softening associated with fruit maturation. In this study, X-ray computed tomography (CT) imaging of the internal structure of peach fruit during ripening was conducted to clarify the differences in the internal structure. The objective of this study was to clarify some of the mechanisms of fruit softening by investigating changes in cell wall polysaccharides. The results revealed that the internal structure of peach 'Hakuho' fruit has vascular bundles running from the peduncle toward the outside pericarp and radially running from the stone to the inner of the fruit. The weight change of polysaccharides in the cell wall showed that pectin decreased in molecular mass in comparison with cellulose as the fruit matured near the stone. In the outer part of the fruit, the degradation of cellulose occurred more rapidly than that of pectin, which was thought to cause the fruit softening. These results suggest that the internal structure of peach 'Hakuho' fruits is different, and that the decomposition of cellulose in the outer part of the fruit is followed by the softening of the inner part due to the degradation of pectin.

Peach, fruit softening, cell wall

PH15

Dissection of mRNA ac4C acetylation modifications in AC and Nr fruits: insights into the regulation of fruit ripening by ethylene

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N 4 -acetylcytidine (ac 4 C) modification of mRNA has been shown to be present in plant RNAs, but its regulatory function in plant remains largely unexplored. In this study, we investigated the differentially expressed mRNAs, lncRNAs and acetylation modifications of mRNAs in tomato fruits from both genotypes. By comparing wild-type (AC) tomato and the ethylene receptor-mutant (Nr) tomato from mature green (MG) to six days after the breaker (Br6) stage, we identified differences in numerous key genes related to fruit ripening and observed the corresponding lncRNAs positively regulated the target genes expression. At the post-transcriptional level, the acetylation level decreased and increased in AC and Nr tomatoes from MG to Br6 stage, respectively. The integrated analysis of RNAseq and ac 4 C-seq data revealed the potential positive role of acetylation modification in regulating gene expression. Furthermore, we found differential acetylation modifications of certain transcripts (ACO, ETR, ERF, PG, CesA, β-Gal, GAD, AMY, and SUS) in AC and Nr fruits which may explain the differences in ethylene production, fruit texture, and flavor during their ripening processes. The present study provides new insights into the molecular mechanisms by which acetylation modification differentially regulates the ripening process of wild-type and mutant tomato fruits deficient in ethylene signaling.

ac4C modification, tomato, ethylene, fruit ripening, mRNA

PH16

Physicochemical and nutritional quality of new loquat cultivars

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The loquat cultivation in Spain is centered in the 'Algeri' variety and some of its mutations. This has led to the need to expand the varietal range with cultivars of high physicochemical and nutritional quality. In the present work, it was carried out a comparative study of ten loquat varieties belonging to the breeding program developed at the Valencian Institute of Agricultural Research (IVIA) in collaboration with the Callosa d'En Sarria Loquat Protected Designation of Origin (P.D.O.). At the commercial harvest moment of each variety, physicochemical parameters (total soluble solids (TSS), acidity and soluble tannins (TS)) and biocomponents concentrations (sugars, organic acids and individual phenolic compounds) were determined. All varieties showed TSS levels above 10 Brix, that is the minimum value established for loquat commercialization. However, 'Algar15', 'Algar158' and 'Algar72' stood out for their highest TSS content, above 12.5 Brix. The major individual sugar found in all varieties was sucrose. 'Algar15', 'Algar72', 'Xirlero', 'Andres', 'Juliana' and 'Ruchey' showed the highest acidity levels, between 1.1 and 1.2 g/100mL, while 'Siscar' presented the lowest values, close to 0.85 g/100mL. Among the individual acids, malic acid showed the strongest correlation with fruit acidity. 'Algar15', 'Algar158', 'Xirlero' and 'Juliana' presented the highest TS content, above 0.04%, while 'Algar5', 'Ruchey' and 'Siscar' showed the lowest levels, close to 0.01%. Chlorogenic acid was identified as the major phenolic compound in all varieties and, together with neochlorogenic acid, showed strong positive correlations with the concentration of soluble tannins.

Fruit quality, acidity, sugars, metabolites content

PH17

Stimulus-responsive QR codes: potential cost-effective options for intelligent packaging

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Intelligent packaging solutions have undergone extensive development and attracted increasing interest within the packaging industry. However, their widespread adoption in real-world applications has been limited by the significant added costs associated with electronics-based systems, despite the innovative and intelligent functionalities they offer. Various efforts to reduce these costs, including the introduction of compact printed electronics, battery-free options, and the use of low-cost materials, have not yet achieved substantial breakthroughs. This ongoing challenge led us to explore a more cost-effective alternative by enhancing the functionality of Quick-Response (QR) codes. Initially developed by Denso Wave, Japan in 1994 for inventory management, QR codes have evolved into a critical tool across many industries, owing to their ability to store more information than traditional barcodes and their capacity to be scanned both vertically and horizontally. The widespread availability of smartphones has made QR code scanning a regular part of daily consumer interactions. In the agriculture and food sectors, QR codes are instrumental in providing traceability and product authentication, as well as facilitating real-time marketing and data analytics. Beyond simple data storage, QR codes have revolutionised smart packaging, enabling brands to offer value-added content, monitor product conditions, and strengthen consumer trust and brand loyalty. In this context, we propose the development of stimulus-responsive QR codes, which adapt to environmental changes such as temperature, humidity, or UV exposure. This dynamic feature would allow certain QR code elements to alter in response to specific stimuli, enabling real-time monitoring and providing both suppliers and consumers with critical information about product conditions. By integrating these dynamic QR codes, packaging can become a more interactive, trustworthy, and informative tool, revolutionising consumer engagement across industries.

PH18

In vitro acaricidal activity of longan seed hexanoic extract against African red mite

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Utilization of wastes from the dried longan production industry, especially longan seeds, is an urgent consideration. The use of those wastes as a green pesticide in horticultural crops is of interest. The objective of the present study was to evaluate the acaricidal activity of hexanoic extract from longan seeds (*Dimocarpus longan* Lour.) against the African red mite (*Eutetranychus africanus* (Tucker)) in the laboratory using the leaf dipping method. The acaricidal activities evaluated were killing activity, repellency effect and egg-laying inhibition. The results revealed that the longan seed hexanoic extract exhibited a highly toxic effect on the mites, with LC 50 values of 0.599% and 0.398% at 24 and 48 h after treatment, respectively. At a 0.2% concentration, the extract was extremely repellent against the mites, with 70% repellency after 24 h. Furthermore, at a 0.3% concentration, the extract exhibited high egg-laying inhibition, with a mean of 0.17 eggs laid, significantly different from the blank group (3.07 eggs). Therefore, the longan seed hexanoic extract is appropriate for effectively controlling the African red mite. However, the further study is required to determine the appropriate rate of use under field conditions.

Dimocarpus longan, Eutetranychus africanus, killing activity, repellency effect, egg-laying inhibition

Storage duration, harvest injury, and fungal pathogens promote ethanol accumulation in postharvest sugarbeet roots

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Sugarbeet (*Beta vulgaris* [L.]) roots are stored in large outdoor piles or sheds for up to 140 days before freezing for long-term storage or processing into sugar. During this storage period, roots are known to lose sucrose to respiration and storage diseases. However, recent observations by a U.S. sugarbeet processor suggest that additional sucrose may be lost due to ethanol formation. Presently, no studies have quantified ethanol production in stored sugarbeet roots or evaluated abiotic or biotic factors that may influence postharvest ethanol accumulation. Research was conducted to quantify ethanol production in stored roots and identify environmental and microbial factors that may promote its accumulation in storage. Changes in root ethanol concentration were determined as a function of time in storage and reduced ventilation, and in response to wounding and common storage pathogens. These studies demonstrated that ethanol concentration progressively increased with time in storage. However, reductions in oxygen concentration and increases in carbon dioxide concentration that were made to mimic the atmospheric conditions surrounding roots when ventilation is insufficient had no impact on ethanol concentration of stored roots. In contrast, wounding had a small but significant increase in ethanol accumulation, while infection of roots by the fungal pathogens, *Botrytis cinerea* and *Penicillium vulpinum*, increased ethanol concentrations, respectively. An examination of the expression of ethanol biosynthetic genes as a function of storage duration found that both of the two genes that encode pyruvate decarboxylase and two of the nine genes encoding alcohol dehydrogenase were upregulated during storage. These studies provide the first evidence for ethanol accumulation in stored sugarbeet roots and identify abiotic and biotic factors that affect ethanol accumulation in postharvest sugarbeet roots. This information is expected to aid the sugarbeet industry in developing strategies to reduce sucrose fermentative losses.

Beta vulgaris (L.), ethanol, storage, sugarbeet, sugar, Botrytis cinerea, Penicillium vulpinum, postharvest physiology

Fortification with amino acids: a method to capture the benefits of nitric oxide and hydrogen sulphide in extending fresh produce's postharvest life

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Substantial research over the past two decades has demonstrated the ability of the signalling gaseous molecules, nitric oxide (NO) and hydrogen sulphide (H_2S), to prolong postharvest shelf-life of a wide range of horticultural produce. However, commercial scale fumigation using NO and/or H_2S gas presents significant challenges due to the inherent toxicity and reactivity of both gases. While various synthetic NO and H_2S donor agents, developed for medical research, have been successfully applied in horticulture postharvest research, the high cost of many products coupled with the lack supporting toxicity data would make it difficult to gain regulatory approval for their postharvest application. We examined the metabolic sequences found from numerous animal and plant studies that lead to endogenous production of NO and H_2S and have identified the amino acids, arginine (Arg), cysteine (Cys) and methionine (Met) as naturally occurring precursors of NO and H_2S synthesis. These amino acids have GRAS status and would therefore seem to be acceptable to regulators and consumers. In addition, their high solubility in water makes dipping a feasible application method. This paper reviews the metabolic involvement of Arg, Cys and Met in the synthesis of NO and H_2S and present findings from our pilot studies that support the contention of beneficial postharvest effects from dipping in solutions of the amino acids. We are proposing that research needs to be conducted with a wide range of fresh produce to determine the benefits that can be attained with Arg, Cys and Met.

Arginine, cysteine, methionine, nitric oxide, hydrogen sulphide

Pre-storage UV-C treatment as an alternative method to maintain the quality of Brussels sprouts

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Pre-storage of UV-C treatment (180-280 nm) has been shown to delay the ripening and senescence in a range of fresh fruits and vegetables. Freshly harvested Brussels sprouts (*Brassica oleracea*) were exposed to UV-C lights at four different intensities at 20°C then stored for up to 21 days at 5°C and 90% RH. Ethylene production, respiration rate, total soluble solids (TSS), titratable acidity (TA), vitamin C, total chlorophyll content, ion leakage, PAL and antioxidant activities were assessed at seven days intervals. The results showed that pre-storage UV-C treatment significantly affected respiration rate and ethylene production, and this UV-C treatment effect was not dose dependent, where there were no differences in respiration rate and ethylene production between UV-C dosages. UV-C treatment also had significant effect on antioxidant activity, TSS, TA and vitamin C content. UV-C treatment exhibited no significant impact on ion leakage, total chlorophyll and PAL activity. These results show that a pre-storage UV-C treatment could be a potential postharvest treatment that can delay the senescence of Brussel sprouts.

Brussels sprout, storage, postharvest, ethylene, respiration.

PH22

Case study on cucumber transportation using modified atmosphere packaging to prevent postharvest deformation, blossom-end enlargement

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In this study, the effects of modified atmosphere (MA) packaging on the occurrence of post-harvest deformation and blossom-end enlargement (BEE) in cucumber fruits were investigated in real transportation. After harvesting, the cucumbers were transported by refrigerated trucks to the Tokyo wholesale market located 550 km from the production area over 2 days. They were then stored at the destination at 27°C for 6 days after arrival. Two types of films were compared: a porous mineral-containing polyethylene film and perforated polyethylene film. Overall, packaging with the MA film and porous mineral-containing polyethylene film suppressed the occurrence of BEE compared to packaging with a conventional polyethylene film. However, the effect of MA packaging was inconsistent between producers and shipping cases, even within the same producer. The gradual changes in the gas composition inside the packaging during transportation were measured. Packaging with low BEE tended to maintain low oxygen and high carbon dioxide concentrations. In contrast, packaging with high BEE tended to have high oxygen and low carbon dioxide concentrations. This suggests that the variation in the MA effect is affected by the airtightness of the packaging and that slight differences in airtightness among producers and individual packaging methods are amplified by vibrations during transportation. Logistic regression analysis estimated that an oxygen concentration of 8.13% and a carbon dioxide concentration of 8.87% were necessary to suppress BEE occurrence. In conclusion, for MA packaging to exhibit sufficient performance, it is necessary to establish a packaging method whose airtightness is not affected by vibration during transportation and a work procedure that does not cause differences between producers.

Fruit deformation, individual differences, modified atmosphere packaging, storage condition, transportation

Effect of ethyl formate and low pressure storage on the quality of green capsicums

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Green capsicums (*Capsicum annum L.*) were stored under ethyl formate and low pressure (1.3 kPa) at 5°C for 6 and 11 days with 100% RH. Upon removal from low pressure storage and after being transferred to normal atmosphere (101 kPa) at 5°C for 7 days and at 20°C for 2 days, fruits quality were assessed. The results showed that there was no difference between treatments after 6 days storage at 5°C and 7 days at 101 kPa at 5°C, however the addition of 2 days at 20°C (101 kPa) significantly increased in the level calyx rots on ethyl formate treated fruits. After 11 days storage at 5°C showed an increase in flesh rots in ethyl formate treated capsicums for 2 days at 1.3 kPa as compared the treated fruits at 101 kPa. Fruit weight loss significantly increased in fruit which stored at low pressure (1.3 kPa) for 11 days at 5°C then 7 days at 5°C. Fruits treated with ethyl formate for 2 days at 1.3 kPa showed low in acceptability than air control fruits. In addition, fruits fumigated with ethyl formate for 2 days at 101 kPa were significantly softer than air stored fruit at 101 kPa. These results demonstrate the additional of ethyl formate on low pressure storage resulted in low fruits quality and in some capsicums treated with ethyl formate were in unacceptable level.

Storage, postharvest, quality, rots, firmness

Selenium biofortification affects postharvest in horticultural crops

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The biofortification of leafy vegetables and fruit crops with selenium (Se) is a valid way to increase the dietary Se intake in humans. In plants, selenium enhances the antioxidant capacity of tissues and, at non toxic concentrations, is effective in altering some physiological processes, including fruit ripening and senescence. The effects of the addition of selenium (by spraying the whole plant or adding Se in the hydroponic solution) on the shelf life and storage of chicory (*Chicorium intybus L.*), lettuce (*Lactuca sativa L. var. Acephala*), basil (*Ocimum basilicum L.*) and tomatoes (*Solanum lycopersicum*) have been investigated. Plants were grown in hydroponics and selenium was added as sodium selenate to chicory and lettuce (at dose of 0.5 and 1 mg Se L^{-1}) and basil (4, 8 and 12 mg Se L^{-1}), and as sodium selenate (1, 1.5 and 10 mg Se L^{-1}) and selenium nanoparticles (5 and 10 mg Se L^{-1}) to tomato. Both methods of Se distribution resulted in an increased selenium concentration either in leaves of leafy vegetables and in tomato fruit. Selenium positively affected yield in chicory and lettuce, but not in basil and tomato. Selenium resulted generally effective in decreasing the production of ethylene and phenylalanine ammonia lyase (PAL) activity in chicory and lettuce. In basil, selenium applied at rate of 12 mg L^{-1} induced an increase of leaf antioxidant capacity, total phenol and rosmarinic acid content. A shift of about 10 days in the onset/evolution of ripening and a lower amount of ethylene at harvest and during the post-harvest phase have been observed but only in tomato fruit enriched with the highest Se concentration applied. At 10 mg L^{-1} selenium decreased the amount of β -carotene, increased the accumulation of naringenin and chlorogenic acid, and decreased the coumaric acid level in tomato fruit. Selenium also affected the volatile organic compound profile of the ripening fruit. These results indicate that selenium enrichment may affect specific processes related to senescence/ripening of the considered crops with effects on the shelf- and postharvest life.

Selenium enrichment, storage, leafy vegetables, tomato

Effects of different packaging methods on the physiology and quality of fresh *Zanthoxylum bungeanum* during storage

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In order to explore the suitable packaging methods for storage of *Zanthoxylum bungeanum*, this study compared the effects of polyethylene terephthalate (PET) box and PET box with holes (PET + hole) packaging on the postharvest physiology and quality of fresh 'Ci Jiao' fruit during storage at 2°C. The results showed that: compared with PET + hole box packaging, PET box packaging effectively delayed the increase in ethylene release rate and respiration intensity of *Z. bungeanum* fruit during storage, inhibited fruit weight loss, cracking and peel browning, delayed the deterioration of sensory qualities such as fruit aroma and stem freshness, and the reduction of total fagaramide content. On the 14th day of storage, the ethylene release rate and respiratory intensity of fruit in the PET box were 26.5% and 12.8% lower, respectively, than those in the PET + hole box. On the 28th day of storage, the weight loss, cracking rate and browning rate of fruit in PET box were 65.4%, 86.2% and 17.4% lower than those of PET + hole box packaging. The sensory score and total fagaramide content were 50.0% and 29.1% higher than those of PET + hole box packaging, respectively. It is suggested that PET box without holes packaging could maintain the sensory quality and numb-taste substances content of fresh *Z. bungeanum* fruit during storage at low temperature.

Zanthoxylum bungeanum, packaging, physiology, storage quality

Effect of storage under controlled atmospheres on quality and volatile compounds of ‘Candy Snap’ table grapes

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Specialty grapes with unique or enhanced flavours can have a high susceptibility to decay, limiting the time that they can be stored, particularly if organic grapes are desired. Controlled atmospheres are known to be effective in controlling decay in table grapes, but it is unclear if key flavour properties of these grapes may be adversely altered. To determine this controlled atmosphere storage treatments of normal air, 1% O_2, 10% CO_2, or 1% O_2 with 10% CO_2 were applied to 'Candy Snap' grapes. 'Candy Snap' is a popular grape that is stated to have a pronounced "strawberry" flavour. likely driven by the high concentrations of volatiles in multiple classes, such as hexanal, E-2-hexenal, linalool, geraniol, nerol, citronellol, 2-phenylethanol and rose oxide. Quality characteristics, including decay, and volatiles associated with desired flavour characteristics were investigated initially and after 3, 6 and 9 weeks of 1°C storage. Treatments containing 10% CO_2 reduced decay dramatically while grapes in air or 1% O_2 suffered more than 60% decay. Treatments with 1% O_2 and 10% CO_2 in combination were effective in maintaining or even increasing overall volatiles relative to the initial samples in air during the storage period. This contrasts with grapes stored in air where volatiles declined over time. Controlled atmosphere storage may be a viable possibility for storage of decay-susceptible, uniquely flavored specialty grapes that are being organically produced and sulfur dioxide cannot be used.

Controlled atmosphere storage, decay, volatile compounds, table grapes, GC-MS, flavour loss

Effect of fertilizer management on fruit preservation in strawberry

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Strawberries are more difficult to preserve for long periods of time than other crops because their skins are easily damaged during the cultivation and distribution process, and their fruits are perishable. Therefore, in order to improve the freshness of strawberry fruits after harvest, we investigated the effect of nutrient solution concentration during cultivation on the quality of strawberry fruit. In this experiment, the quality and fruit weight of strawberry 'Mouikko' cultivars grown under different nutrient solution concentrations (EC 0.9 and EC 2.0 dS/m) were investigated. The nutrient concentration conditions in each experimental field were reversed at 95 days after the start of the experiment. Sugar content (Soluble solids: Brix%), acidity, sugar-acid ratio, fresh hardness, fresh weight, and dry weight were measured in strawberry fruit quality evaluation. Then, the strawberry water loss was calculated from the weight change of the fruit when stored at 5°C for 72 hours after harvest, and this parameter was defined as fruit preservation capacity. As a result, Brix and acidity were higher in strawberries grown under EC 2.0 dS/m condition than in those grown under EC 0.9 dS/m condition during the cultivation period. Fresh hardness was higher in strawberries grown under EC 0.9 dS/m condition. Fruit dry matter content was significantly lower under EC 0.9 dS/m condition before changing the nutrient solution concentration, but no significant difference was confirmed after changing the nutrient solution concentration. Water loss was lower under EC 0.9 dS/m conditions until 72 hours after harvest. These results showed that strawberry fruit quality improved with higher nutrient solution concentrations, but higher fruit dry matter content has the potential to make the fruit perishable. However, under EC 2.0 dS/m condition after reversing the nutrient solution concentration, water loss was kept low until 48 hours after harvest. These results showed that there is a relationship between the nutrient solution concentration and fruit quality in strawberry. Furthermore, it was shown that it is possible to control fruit preservation by controlling the nutrient solution concentration.

Strawberry, fruit preservation, nutrient solution concentration, water loss, dry matter content

PH28

Novel active pectin edible coating with deep eutectic solvent plasticizer and essential oil to extend the quality of banana

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The novel active pectin edible coating was developed with a mixture of glycerol (Gly) and choline chloride (ChCl) as plasticizers, incorporating eucalyptus essential oil (EEO) to extend the quality of bananas compared with uncoated and coated bananas without EEO. A deep eutectic solvent (DES) comprised of a mixture of Gly and ChCl (Gly:ChCl) is an intriguing green plasticizer that can be used in edible coatings. Previous studies have shown that a 10% DES plasticizer is an appropriate amount to provide water barrier and mechanical properties for application on fruit surfaces. Coated bananas with EEO were found to reduce weight loss, maintain fruit firmness, colour, and visual appearance changes, as well as delay the increase in soluble solid content, thereby extending the shelf life of bananas stored at room temperature (35°C) for 9 days. Thus, the small amount of DES green plasticizer and EEO provide an active edible coating to maintain the quality of agricultural produce, which is crucial for reducing food loss and waste to achieve sustainable development goals.

Pectin, deep eutectic solvent plasticizer, eucalyptus essential oil, edible coating, banana

PH29

Effect of detergents and coatings on skin greasiness in WA 38 apples

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Skin greasiness has been the most prominent issue during the first years following the commercial launch of WA 38 in 2019. This external defect negatively affects the waxing process during packaging and consumer acceptance. To explore best practices during packaging, the performance of commercial detergents and coatings were evaluated. Two detergents (neutral and acid) and three coating formulations (carnauba, shellac, shellac-ethyl alcohol) were evaluated on fruit with moderate and no greasiness after 7 months of cold storage (0.5°C). Detergents were applied by hand for 30 or 60 seconds to simulate different brush bed lengths. Greasiness incidence and severity (0~ no grease n 3~ severe) were evaluated daily for seven days at 20°C ('shelf-life'). In general, greasiness progressively increased at 20°C, even on fruit initially without the symptom. Overall, both detergents applied for 30 were able to remove the natural wax effectively. Mild greasiness reappeared after 4 days regardless of the treatment. Coatings were applied on clean fruit after being treated with detergent. In this experiment, greasiness was evaluated weekly for 21 days at 20°C right after application, and again after 1 month of cold storage (1°C) plus another 21 days. In general, shellac and shellac-alcohol treatments were able to control (100%) the appearance of greasiness through the skin up to 49 days post-application with 7 days in cold storage (1°C) in between. Carnauba was able to control greasiness reoccurrence in 90% of the fruit, with an increase in incidence and severity over the shelf-life period. All coatings were able to control weight loss compared to the untreated control. After confirming these results on another set of fruit, they will be included in best practices to manage skin greasiness in WA 38 apples during the packaging process.

Greasiness, coatings, detergents

PH30

Postharvest losses of apple fruit stored in commercial conditions in Estonia, Finland and Norway

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Recent data on postharvest losses of apple fruit in commercial conditions in Nordic countries has not been compared. In the current study, postharvest losses were quantified in commercial storage facilities in Estonia, Finland and Norway in 2023. Three samples of 200-350 kg bins were used per cultivar. The percentage of table fruit, juice fruit and discarded fruit were determined. In Estonia and Finland, colour defects, physiological disorders, mechanical or insect damage, and fungal diseases were identified and interviews were conducted with the largest apple growers to find out their postharvest practises and the reasons for apple losses. In Norway, data was collected from two packinghouses from 2020 to 2023. Five main cultivars in volume, 'Red Aroma', 'Discovery', 'Red Gravenstein', 'Rubinstep' and 'Summerred' were studied. In Finland 'Rubinola', 'Zari' and 'Santana' and in Estonia 'Krista', 'Ligol', 'Antei' and 'Zarja Alatau' were assessed. From Norway, a comparison between storage in controlled (CA) and normal atmosphere (NA) of 'Red Aroma' for about six weeks was included. The amount of table fruit stored in NA differed from 47 to 96%. In mean of three years it was 80% table fruit after CA storage and 72% table fruit after NA storage for 'Red Aroma'. In one of the seasons a high share of the fruit had developed soft scald and from 10 to 20% of the total weight was discarded. On the average of three countries, the amount of juice fruit ranged from 5.2 to 49%. The total of discarded fruit was less than 2% for all other cultivars except 'Krista and 'Antei', which had 6 and 4.1% of discarded fruit, respectively. The main reasons for discarding were physiological disorders followed by fungal diseases. The results of the growers' interviews and cultivar specific reasons to be rejected as table apples will be discussed.

Physiolog

Harvest maturity optimisation for ‘Jin-Huang’ Mango with ethylene sensitivity in ripening attributes

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'Jin-Huang' mango, known as the second-largest mango production in Taiwan, exhibits promising attributes for overseas exportation substantial size averaging 1,200 g, less fibrous, low acidity, and high sugar content. However, the manifestation of fruit disorder, such as spongy tissues escalates with the maturation on the tree. Ambiguity surrounds the optimal harvest maturity, particularly concerning the "ready to ripen" (mature-green stage), complicating commercial operations. In this research, fruit maturity was assessed based on days after full bloom (DAB) at intervals of 90, 105, 120, or 130 DAB. Subsequently, fruit was exposed to 0 (CK) or 100 µL.L -1 ethylene (ETH) at 35°C for 24 hr, followed by a 4-hours air ventilation and transferred to 20°C for 1, 4, or 7 days. Fruit development indicated that approximately 90% of maximum size was achieved longitudinally and transversely during 100-105 DAB, coinciding with the onset of the pit-hardening stage. Regarding external appearance, fruit harvested at different DAB stages transitioned from light green to greenish-yellow. Results revealed that ETH-treated fruit harvested at 105, 120 and 130 DAB demonstrated accelerated colouration to fully yellow compared to those harvested at 90 DAB, only a few fruit exhibited a lightly yellow hint. A similar pattern of colouration was observed on the fruit flesh that fruit subjected to ETH treatment at 105 DAB attained fully-ripe with good quality attributes after 7-day ripening. ETH fruit harvested at 120 DAB and 130 DAB reached full ripeness only after 4-day ripening but with a higher incidence of internal disorder observed (17% and 25%, respectively). Notably, flesh colouration in 90 DAB fruit initiated from the peduncle end toward the bottom, not around the seed. It suggested the heterogeneous maturation of pre-climacteric immature flesh tissues, possibly commencing from the peduncle end toward the bottom. To conclude, 'Jin-Huang' mango exhibits higher ethylene sensitivity on ripening from 105 DAB onward. Although the fruit quality improved in ETH fruit after 105 DAB, optimal harvest maturity with the consideration of preventing fruit disorders, appeared to be around 105 DAB.

Mature-green stage, physiological disorder, heterogenous maturation, pre-climacteric immature tissues

Mitigating post-harvest losses in Central Vietnam's fruit industry

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The fruit value chain faces significant challenges due to post-harvest losses, impacting product quality and the economic sustainability. The Hohenheim-type solar tunnel dryer is as a promising way of minimal processing to increase shelf life. This study delved into the potential of solar tunnel dryer within the context of cooperatives in central Vietnam, aiming to address these challenges. Through comparative trials conducted at the University of Hohenheim, the benefits of solar tunnel dryer over traditional sun drying methods was demonstrated. Results revealed notable advantages for mangoes and bananas, with the dryer achieving lower final moisture content in greatly shorter durations. Only some minor variations were noted in the texture of open sun-dried mangoes compared to their solar tunnel dried counterparts, overall sensory evaluations indicated comparable quality attributes between the two drying methods. Moreover, insights gained from interviews with local farmers underscored a prevailing knowledge gap concerning solar drying technologies. Despite these challenges, economic feasibility studies affirm the profitability of locally built solar tunnel dryers, thus reinforcing their potential for widespread adoption. Powered by a 100 W solar cell, the solar tunnel dryer utilizes the abundant sunlight available in central Vietnam and is equipped with a DC fan for efficient drying. With an initial cost of around €1,600 for locally built dryers, ongoing running costs are low and include regular maintenance and replacement of the greenhouse film. Additionally, the study identified mango, banana, papaya, kumquat, and jackfruit as fruits with significant potential for solar drying, based on market research, interviews, and literature review findings. By fostering sustainable agricultural practices, the integration of solar tunnel dryers holds promise for supporting socio-economic development and resilience in rural communities.

Climate-resilient technology, green innovation, renewable energy, rural development, smallholder empowerment

Local in-transit handling of 'Jewel' tomato from Maragusan, Davao del Norte to Baybay City, Leyte in the Philippines

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Proper postharvest handling is crucial in minimizing losses and improving the efficiency of supply chain management. This study was conducted to assess the postharvest losses in tomatoes transported from Maragusan, Davao de Oro to Baybay City in Leyte (627km) trialling an improved method of handling using additional newspaper linings and reduced fruit load per wooden crate. Two days after arrival in the consignment, tomatoes packed in the wooden crate with reduced fruit load and with four sides lined with newspaper showed no reject fruit. This was in contrast to traditional farming practices, where overpacking without newspaper lining resulted in increased reject fruit due to mechanical and microbial damage at 8.33% and 12.92%, respectively. Tomatoes packed using the two improved methods had better visual quality, resulting in a higher percentage of marketable fruit as compared to those that were traditionally packed without newspaper lining. At 32 days, the improved method using newspaper as linings on all sides showed higher marketable fruit (89.2%), and lower percentage of rejects but still marketable (8.4%) and non-marketable reject (2.32%) compared to traditional handling. Fruit in the bottom and middle layers of the wooden crate resulted in non-marketable rejects mostly due to microbial infection while the bottom fruit layer was prone to mechanical damage, respectively. Improved handling method, two sheets of newspaper lining on all sides of the crates protected the tomatoes from mechanical damage during transport. Even the simple provision of two newspapers on the two sides of the wooden crate was deemed a better practice in tomatoes compared to fruit without it due to better visual quality.

Improved packing method, tomato supply chain, marketability

PH34

Investigating post-harvest physiological changes and ripening characteristics of kiwifruit (*Actinidia chinensis*) produced in Taiwan

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This study investigates the post-harvest physiological changes and ripening characteristics of kiwifruit (*Actinidia chinensis*) produced at an altitude of 1800 meters in Taiwan, aiming to enhance the consistency of fruit maturity. Fruits harvested at 21 to 23 weeks post-flowering, in September 2023, were subjected to two different storage temperatures, 4°C and 25°C, for 11 days. Throughout this period, parameters such as firmness, flesh colour, soluble solids content (SSC), and acidity were monitored. Results indicated that, irrespective of the temperature treatment, there was a significant reduction in firmness (from 2.7N to 1.3N). Furthermore, the L* value from the Colourimeter's Lab readings was the only colour metric showing a significant decline over the period (from 78.3 to 55.7). In terms of fruit quality, SSC increased significantly after 7 days at 25°C (from 12.3 Brix to 19.5 Brix), while it took 35 days at 4°C to achieve a comparable increase in SSC (from 9.4 Brix to 17.3 Brix). The average acidity of the fruit under the 25°C treatment (0.66%) was lower compared to the 4°C treatment (0.97%). Based on these findings, we recommend tailoring storage temperatures to transportation distances to optimize ripeness and flavor. 25°C is suitable for transportation durations of up to 7 days, whereas 4°C is advisable for periods exceeding 35 days.

Actinidia chinensis, physiological change, fruit maturity, fruit quality

An assessment of post-Covid horticultural food loss in Samoa, Fiji, Tonga and Solomon Islands

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Postharvest food loss is a global problem, and the Pacific is no exception. With food insecurity a serious crisis in the Pacific, efforts have been focussed on increased sustainable production of agricultural and horticultural produce. However, these efforts are often undermined by food loss. Pre-Covid, work had been conducted across the Pacific, with records of 5-15% postharvest losses, with intermittent 20% losses often observed from inter-island trade, or with commercial value chains. This paper examines the status of food loss post-Covid in the Pacific, and compares and contrasts food loss between the wet and dry season, in Samoa, Tonga, Fiji and the Solomon Islands.

Food loss, Pacific, postharvest, value chains

Evaluating the quality of fresh Malaysian pineapples during the first export trial to Germany

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Malaysia's pineapple industry ranks 24th in production and fifth in ASEAN, with the MD2 pineapple variety as the leading export. Exploring new markets supports long-term growth and competitiveness for Malaysian pineapples internationally. This study aims to assess the export potential of Malaysian MD2 pineapples to Germany via sea shipment. A trial shipment was conducted between December 2022 and January 2023, from a Global GAP-accredited farm in Ulu Tiram, Johor, to Germany. The pineapples, harvested at the mature green stage (135–140 days after flower induction), were cleaned, graded, and treated with a commercial surface coating. A total of 1,500 boxes (each containing 7–8 pineapples) were transported in a 40-foot refrigerated container at 7 ± 0.5°C and 95–98% relative humidity for six weeks from Tanjung Pelepas Port, Johor, to Rotterdam Port, Netherlands. From Rotterdam, the pineapples were transported by land to Cologne, Germany, where their quality was assessed simultaneously at the importer's warehouse and MARDI Headquarters in Serdang, Malaysia, on the same day. The quality parameters evaluated skin and pulp colour, chilling injury, blackheart disorder, pulp translucency, total soluble solids, titratable acidity, and overall acceptability. The results showed that the MD2 pineapples arrived in good condition and were well-received by German consumers. The study concluded that Malaysian MD2 pineapples have considerable export potential in Germany; however, extended logistics times and high transportation costs necessary to maintain optimal fruit quality may hinder their market price competitiveness.

Ananas comosus var. MD2, quality, cold storage, export, sea shipment

PH37

Classification of rotten taro for automatic sorting system using near-infrared spectroscopy and k-Nearest Neighbor model

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Sorting of taro is generally used for visual inspection and it is difficult to distinguish the rotten taro from healthy taro due to the little difference of appearance. We developed the k-Nearest Neighbor (kNN) to classify the rotten taro using near-infrared spectroscopy (NIR) for automatic sorting system of taro. The spectral data of rotten and healthy taro were measured at 10 nm intervals from 1750 to 2150 nm using a NIR sensor module. Based on the principal component (PC) obtained from the principal component analysis, a nonlinear discriminant model using the kNN model was developed. The spectral data set was randomly divided 7:3 between train for model development and test for model validation. In this study, kNN model was consisted of k =5 as parameter and Euclidean distance as distance index. For the model validation, the accuracy was calculated using the confusion matrix. The results of the nonlinear discriminant model using kNN model showed that PC 1 and PC 2 were selected for the horizontal and the vertical axis, respectively. The accuracy for 74.1% was obtained for the rotten taro classification with test data. This accuracy was higher compared to the linear discriminant model for 60%. Our results suggested that kNN model of rotten taro classification using NIR would be contributed for automatic sorting system of taro.

k-Nearest Neighbor, near infrared spectroscopy, rotten taro, sorting system

PH38

ControlTec™: Water sustainable use across ControlTec applicator washer

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Moving fruit through the post-harvest process efficiently and effectively, while avoiding food waste and making the least ecological impact possible to conserve the planet's resources, is a growing challenge. AgroFresh has successfully developed technological solutions, the ControlTec line of equipment, aimed at reducing water consumption in fruit and vegetable production. A review of the results of commercial experiences in Chile and Brazil for apple, mango, avocado and citrus crops compared water consumption and expenditure with standard equipment used by customers versus ControlTec Applicator Washer technology. The nozzle expenditure per minute was measured and the number of nozzles for each type of equipment was counted to obtain the consumption. This was added to the number of daily working hours of the equipment. The results showed an average reduction of 78.3% in the consumption of water used for processing these crops. The highest efficiency was recorded in apples, where an average reduction of 88% in water consumption was achieved during the season, while mangoes achieved a 65.6% reduction in the daily consumption of water used in packaging for processing. This reduction resulted in water savings in mangoes of 16,196,000 liters, while in apples it was an average of 8,458,855 liters less per season. Innovative technologies that transform post-harvest, helping to reduce and optimize water use and product consumption is part of the changes the industry is demanding. The ControlTec equipment provides value by offering sustainable and efficient solutions for use around the world.

Sustainability, sustainable water saving, ControlTec, post-harvest, innovation

Hyperspectral imaging for estimating substances related to enzymatic browning of strawberry fruits

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Strawberries have a relatively high respiration ratio compared to that of other fruits, in addition a large amount of water evaporates from the fruit; therefore, their quality deteriorates over a short period during storage. Four varieties of strawberries were stored for seven days under 0°C; storage conditions, and found that quinone, which is related to enzymatic browning, significantly increased in 'Tochiotome' after three days of storage. As few reports on the investigation of browning substances in strawberry fruits during storage tests are available, it is necessary to develop an experimental method to continuously investigate the same fruit. Generally, destructive analytical techniques such as mass spectrometry and high-performance liquid chromatography (HPLC) are used to analyze fruit and vegetable components. However, as destructive measurements require time and effort, research on non-destructive measurements is underway in addition to destructive measurement. Research on nondestructive measurements were conducted to evaluate and inspect the fruit and vegetable quality using hyperspectral imaging with hyperspectral cameras. Therefore, this study investigated the changes in quinone content during the storage period of strawberries using two strawberry cultivars with different skin colours, 'Suzuakane' and 'Tochiotome', and hyperspectral imaging was used to investigate the changes in quinone content of these substances. In the experiment, each strawberry was stored at 25°C; for five days. Strawberries were then photographed using a hyperspectral camera (SPECIM IQ, 400-1000 nm) before storage (0 day), and 3 days and 5 days after storage, after which the quinone content was measured. PLS regression analysis was performed using the obtained imaging data, a calibration curve was created, and evaluation was performed using full cross-validation. The quinone content increased during the storage period in both varieties. The accuracy of the quinone calibration curve was 0.53 for 'Suzuakane' and 0.58 for 'Tochiotome'. Therefore, the quinone content increased in both varieties during storage, suggesting that enzymatic browning may have occurred. Furthermore, the accuracy of the calibration curve for quinone content using hyperspectral imaging tended to be high, suggesting the possibility of using hyperspectral imaging for the non-destructive measurement of quinone content during storage.

Strawberry, browning, post-harvest, storage, non-destructive measurement

PH40

Development of automatic sorting system for taro using image processing

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The harvested taro was traditionally sorted based on visual inspection by hand with the shape of taro in the grading facility. It is very difficult to sort taro between excellent and good grades because of no clear criteria. In this study, the automatic machine vision sorting system for taro with image processing was developed for labor saving in the grading facility. Image of taro was obtained with digital camera from three directions. The image features included the aspect ratio (width / length), circularity, projected area, and circumscribed circle area were calculated after image binarization. The neural network model with three layers for input, middle, and output were used for the grade judgement of taro. In this study, four parameters of taro shape features, such as the aspect ratio, the circularity, the aspect ratio / the circularity, the projected area / the circumscribed circle area were used for input layer. The output layer was consisted of two grades for excellent and good grades. To assess the model performance, the accuracy was defined as the percentage of correctly classified taro grade (true positives). Our results showed that the accuracy for 76.7% was obtained using the neural network model with four neurons of taro shape features in the input layer.

Sorting system, grade judgement, image processing, neural network model, taro

Linear regression analysis approach to predict fruit quality attributes and metabolic variables for fruit maturity in two strawberry cultivars

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The contents of primary and secondary metabolites in strawberry (*Fragaria x ananassa Duch.*) fruit are altered during fruit ripening along with fruit pigmentation. Thus, the objectives of this study were to elucidate targeted metabolic responses to fruit maturity and to identify any potential biomarkers on fruit pigmentation-based maturity of 'Kuemsil' and 'Kingsberry' strawberry cultivars. The fruits were harvested at 0, 50, 75, and 100% of red pigmentation coverage, regarded as fruit maturity. Fruit firmness, titratable acidity (TA), lightness (L *), and hue angle (h) were decreased but fruit weight, soluble solids content (SSC), SSC/TA, water content, redness (a *), and chroma (C *) were increased with fruit maturity in KS cultivar. The contents of glucose, fructose, and fumaric acid increased but the levels of citric and shikimic acids gradually decreased in both cultivars. Of amino acids, serine, glutamine, alanine, threonine, tyrosine, and leucine rapidly increased after fruit pigmentation. Based on the results of linear regression analyses, 7 physiological attributes (fruit fresh weight, fruit diameter, peel a *, peel h, firmness, SSC, and SSC/TA), 3 organic acids (citric, shikimic, and fumaric acids), 2 amino acids (leucine and glutamic acid), and 5 VOCs (methyl hexanoate, α-terpinolene, linalool, methyl benzoate, and (E)-ocimenol) could be considered as potential biomarkers for the prediction of fruit maturity in 'Kuemsil' cultivar. However, peel colour variables (L *, a *, C *, and h) and 2 VOCs (linalool and (E,Z)-2,6-nonadienal) would be only considered as potential biomarkers in 'Kingsberry' cultivar. Therefore, the results indicated that the identified cultivar-specific potential biomarkers to predict strawberry maturity can be applied for fruit quality management. (This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through 'Smart Agri Products Flow Storage Technology Development Program' funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA; Grant No. 322052052HD030).)

Amino acids, fruit colour, fruit quality, organic acids, pigmentation, strawberry, volatile organic compounds

PH42

Non-destructive optical method to detect zucchini fruit held at chilling temperatures by using VIS-NIR and NIR hyperspectral imaging and supervised classification algorithms

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Zucchini is a chilling sensitive fruit although it is often held at temperatures below 5°C during the distribution chain. For this reason, rapid and early detection of zucchini previously stored at chilling temperatures would allow the correct reallocation of this fruit. This research aimed to explore the potentiality of digital and hyperspectral imaging for the early detection of chilled fruit. To this scope zucchini fruit (cv. Asso) were stored at 2°C, and 12°C for 9 days, soon after harvest. Hyperspectral images and digital images were taken at 2, 6, and 9 days of storage. Chilling injury (CI) was assessed according to the presence of yellow discolouration of the flesh area and surface pitting, evaluated after one additional day at room temperature to allow symptoms to develop. Supervised classification models were developed using Partial Least Square Discriminant Analysis (PLS-DA) on hyperspectral data to classify zucchini fruit based on storage temperature. The result shows that with VIS-NIR spectra was possible to discriminate chilled fruit with accuracy of 90, and 92% in calibration and prediction, respectively, already after 2 days of chilling temperature. Accuracy increased to values higher than 98% with an increase in the length of storage. The model obtained with NIR spectra allowed 100% accuracy in prediction, for fruit stored for 9 days but lower performance with fruit stored for shorter periods, if compared to VIS-NIR. Additionally, different Machine Learning (ML) algorithms were applied to colour images. Among all Neural Network (NN) performed best in classifying the fruit from 2 temperatures after 3, 7, and 10 days of storage reaching an accuracy of 91, 84, and 77% respectively, in calibration, and 100% in prediction. These results shows the potential use of non-destructive optical methods for discriminating fruits stored at chilling temperatures assuring high-quality produce in the market.

Hyperspectral images, zucchini, VIS-NIR, NIR, PLS-DA, machine learning

Retention of postharvest okra (*Abelmoschus esculentus L.*) freshness by focusing on stem end length during preparation

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Okra (*Abelmoschus esculentus L.*) is available year-round in Japan; from May to October, it is available as a domestic commodity and from November to April (spanning the Japanese off-crop season) as an imported commodity from the Philippines and Thailand, among other countries. Okra faces substantial quality degradation owing to its high respiration rate and edible immature fruit. Therefore, during prolonged transportation from production areas to the main consumption areas in Japan and other countries, okra exhibits weight loss and wilting due to transpiration, resulting in black spots, mold, and yellowing of the fruit surface. In this study, two experiments were performed to establish a freshness retention method for postharvest okra. The first experiment involved market research conducted over two years (from April 2022 to March 2024) in, Kanagawa, one of the main consumption areas in Japan. It aimed to examine the quality and morphology (fruit length and stem end length) of okra commodities. Results revealed that 97% of these commodities exhibited black spots, with some showing stem end wilting and cut end browning. Although Japanese shipping standards typically mandate a stem end length of 7-10 mm, lengths of okra commodities vary from 3 to 22 mm. In the second experiment, two cultivars of five-ridged okra were tested to investigate postharvest quality deterioration based on two stem end lengths: 20 and 10 (control) mm. After storage in the dark at 25°C for 10 days, postharvest okras with longer stem ends than the shipping standards exhibited reduced weight loss and wilting. Focusing on stem end length during preparation could be introduced to production areas as a simple and easy-to-perform freshness retention method. In the future, we will assess the impact of stem end length during preparation on postharvest okra weight loss and its effect on freshness retention during cold storage.

Cultivar, market research, preparation method, postharvest disease, weight loss, wilting

PH44

Novel biosensor for precision horticulture: Real-time monitoring of plant sap's ionic content

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The advancement of plant-specific biosensors and their subsequent application, holds significant promise for uncovering novel insights into plant physiology while advancing the field of precision agriculture. Real-time monitoring of the physiological status of plants would enhance input management, thereby optimizing economic returns and promoting sustainable agricultural practices. Here, we present a novel, low-cost, ion-selective transistor capable of selectively and accurately measure at the minute scale the potassium ion variations over extended periods. Our sensor is based on organic electrochemical transistors (OECTs) that use organic mixed ionic-electron conductors (OMIECs), making it particularly suitable for in vivo analyses without disrupting the physiology of the plant. This bioristor effectively detects distinguishable patterns of daily variations related to the plant's hydration status. This technology offers the capability to monitor in real-time the plant metabolic activity and therefore early detection of abiotic stresses prior to the apparition of observable symptoms. By enabling proactive management strategies, these biosensors possess the potential to revolutionize and facilitate the advancement of precision horticulture practices. Our research emphasizes potassium ions due to their critical significance in plant physiology (e.g., fruiting and abiotic stress resistance). However, this technology will soon be extended to the detection of new ions (e.g., pH, Ca^{2+}, Mn^{2+}, NH_4^+...). The sensor has been validated on pine plantlets, we are currently looking at expanding the range of application to fruit-bearing vines/trees such as kiwi, apple, and grapevine. We hope that this technology will enable to monitor the physiological status of plants during the whole year including the post-harvest and wintering phases.

Primary sap, nutrition, OECTs, biosensor, potassium

Raspberry fruit quality and sensory organoleptic traits affected by climate change

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Climate change studies on fruit quality and how it will affect flavor are scarce. According to the IPCC (Intergovernmental Panel on Climate Change), only six major fruit crops have received scientific attention: apples, coffee, grapevines, olives, cocoa, and almonds. Raspberries, however, should be addressed by the scientific community. Raspberries in Chile are cultivated from the central area to Patagonia, where 70-80% of raspberries are produced in peasant family farms, contributing to their low-income subsistence. Therefore, it would be relevant to investigate climate change factors to generate mitigation strategies that help small growers. Temperature studies imposing heat increment have contributed to simulated climate change. Heat treatments using portable polyethylene films have been an appropriate technique for field studies in wheat, soybean, rice, and potato, among others. This study aimed to determine the impact on fruit quality and the sensory impact of heating treatments on raspberry fruit cv. Heritage during 2022/2023 and 2023/2024 summers (Southern Hemisphere). Raspberries were studied in two orchards: one with high background temperatures (northern Chile) and one with lower background temperatures (southern Chile). At fruit set, three portable heating chambers were installed to impose the increased temperature treatment in each orchard, and each chamber enclosed ~5-6 raspberry plants within a row. A temperature increment of 4°C was achieved by one electrical heater per chamber. Fruit was picked at the full red stage (commercial fresh market harvest). Results showed that heated fruit presented smaller fruit size, and the sugar/acid (TSS/TA) ratio increased; suggesting that the raspberry fruit might be losing this organoleptic trait. Sensory analysis with a trained panel showed no differences in flavour in the orchard with a high background temperature; however, in the orchard with a low background temperature, the trained panel detected lower/higher acidity in fruit from heated plants. (Funding by Fondecyt Regular N 1221725).

Temperature increment, heating chamber, sensory analysis, fruit ripening

1-MCP helps prevent fry colour darkening attributable to the use of ethylene as a sprouting inhibitor

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For chipping or frying processing of potato tubers, a light fry colour is the desired quality characteristic. Low temperature (especially below 5°C) results in cold induced sweetening, a natural accumulation of reducing sugars in the potato in response to cold stress. Extended storage periods result in senescent sweetening. These reducing sugars result in a dark fry-colour at the high temperatures involved in the frying process. Low levels of ethylene can stimulate the tuber metabolism and have been associated with increasing reducing sugar content. However, ethylene is also an effective sprout control agent, and a leading option to replace the banned CIPC in the European Union. This study investigated the use of the potent ethylene antagonist 1-methylcyclopropene (1-MCP) on the formation of reducing sugars attributed to the use of ethylene as a sprout inhibitor. It was determined that 1-MCP helps prevent the darkening of potato fry colour attributable to ethylene without reducing the effectiveness of ethylene as sprouting inhibitor. Multiple trials have shown an improvement in fry colour as well as a lower content of reducing sugars. 1-MCP can be used to control fry colour darkening induced by ethylene without blocking ethylene control of tuber sprouting. The mode of action and performance data are described in this presentation.

Potato, 1-MCP, Fry colour, ethylene, sprouting

SmartFresh™ and avocado growth location and maturity

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The avocado fruit (*Persea americana* Mill.) is a highly demanded product worldwide. The main exporters are in the southern hemisphere (Mexico, Peru and Chile) while the main importers are in the northern hemisphere (United States, Europe and the Far East). To get the demand of these markets, it is necessary to produce a high quality and homogeneous product; and be able to maintain this condition throughout the supply chain (20 to 60 days in cold storage). However, one of the main characteristics of avocado is its very high heterogeneity of ripening (flesh firmness and skin colour) and its physiological characteristics (high respiration and ethylene production), which threaten its storage life, challenging the described objective. Several strategies and technologies are used to minimize these problems, both at orchard, pre-harvest and post-harvest levels. SmartFresh™ (1-Methylcyclopropene - 1-MCP) is a postharvest growth regulator that blocks the action of ethylene by binding to its receptors, temporarily inhibiting the ripening of climacteric fruits, extending their postharvest life; however, in the case of avocado, this blockage can generate ripening problems for certain stages of harvest maturity. The objective of this trial was to determine the effects of SmartFresh™ on postharvest ripening of Hass avocados harvested with low dry matter (≈23% approx.) and advanced (60 days after the first harvest), from two microclimates according to growth exposure to the sun (northern and southern exposure) and from different production zones in Chile. The results indicate that SmartFresh™ is very effective in delaying avocado ripening, however, with low dry matter (23%) the time to reach eating maturity after 10 days was considerably increased. On the other hand, fruits produced in a northern exposure took more days to reach eating maturity when exposed to 20°C ("shelf life") than those coming from southern exposure. These factors are important to consider when adopting postharvest technologies in order to achieve a homogeneous product that can reach the most distant markets with the required quality.

SmartFresh, 1-MCP, avocado, ripening, pre-harvest, postharvest, ethylene

Biochemical and sensory attributes of jujube juice and syrup

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Two products (juice and syrup) were prepared from two different ripeness stages (Yellow and Brown) of eight different genotypes of ber including V 1 Akash, V 2 : Anokha Karela, V 3 : Imran Karela, V 4 : Moon, V 5 : Pak White, V 6 : Sabz Karela, V 7 : Seedless and V 8 : Sofun Koroneiki. The assessments were made regarding different biochemical attributes (total soluble solids, pH, titratable acidity, vitamin C, TSS, superoxide dismutase, peroxidase, catalase, protein contents, total phenolic contents, total antioxidant contents) and organoleptic properties (taste, flavour, colour, and aroma). A significant difference was found among the ber juice and syrup regarding all the studied biochemical and organoleptic attributes with syrup having better turnout than juice extract. The main effects of different ripeness stages and genotypes were found significant for titratable acidity, total soluble solids, pH, total phenolic contents and antioxidant capacity, vitamin C, protein contents, peroxidase, catalase, and superoxide dismutase. Similarly, a significant interaction was found between products, ripeness stages, genotypes, and biochemical attributes. Overall, the results revealed the presence of significant biochemical activities in the juice and syrup of ber which are affected significantly influenced by the ripeness stage and genotypes.

Jujuba mauritiana, ber, value addition, postharvest quality

PH49

VitaFresh™ Botanicals Soft Fruit: A novel plant- based coating for nectarines and plums

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VitaFresh Botanicals Soft Fruit is a vegetable oil-based formulation that was developed specifically for the treatment of nectarines and plums. The use of coatings for these crops has historically been a challenge, thereby having a coating compatible with the post-harvest handling and processing is novel for the market. The performance benefits acquired by use of this coating include the extension of fresh quality of fruits both during cold storage and in retail market conditions. It also helps reduce fruit weight loss, improve external appearance, and reduce symptoms of senescence and dehydration. This extension of post-harvest quality offers the possibility of extending the current commercial season while also providing opportunities for geographical expansion into new and more distant markets. The formulation is compatible with current pack line equipment through spray applications, and allows its mixture with certain fungicides, which complement the overall treatment. The representative performance data to support the information is detailed in this presentation.

Nectarine, Plum, Coating, dehyration, VitaFresh Botanicals

Postharvest treatments and sensory properties of apple cultivars ‘Rubinstep’ and ‘Red Elstar’

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In Norway, there is political goal to increase the degree of self-sufficiency of fruits. To achieve this goal, the sales period of Norwegian produced apple fruit needs to be extended, and thus, the storage technology improved. Sensory quality is of importance for consumers acceptability of the apple fruit. The aim of this study was to evaluate the sensory properties of the apple cultivars 'Red Elstar' and 'Rubinstep' treated with 1-methylcyclopropene (1-MCP) in combination with storage in regular and controlled atmosphere. Before storage, the harvested fruit were divided into two parts; half treated with 1- MCP and the other half untreated. A semi-trained sensory panel evaluated selected sensory properties of apple fruit harvested in 2021, 2022, and 2023, and stored in regular controlled atmosphere at 2°C for 5, 5, and 4 months, respectively. Treatment with 1-MCP in combination with controlled atmosphere storage resulted in the highest sensory score of firmness, crispiness, and juiciness, and lowest score for mealiness and sweetness. Fruit stored in a regular atmosphere without 1-MCP had less acidity and the most fruity aroma. How to obtain optimal taste of 'Rub instep' and 'Red Elstar' after the different post-harvest treatments will be discussed.

1-methylcyclopropene, controlled atmosphere, quality parameters, sensory quality, long-term storage

Improving quality and shelf life of fresh tomato fruits with post-harvest exogenous melatonin application

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Tomato is one of the most consumed and produced vegetable crops worldwide and in the Republic of Benin, where it contributes to increasing rural communities' income. Tomato fruit production and storage face several challenges with the fruits characterized by a short shelf life that impairs their availability. With the aim to maintain post-harvest quality and improve the shelf life of tomato fruits after harvest, several assays were conducted to investigate the impact of melatonin on tomato fruit preservation and quality. Melatonin is an indole, natural, and toxic-free compound, involved in biotic and abiotic stress impact mitigation and could be useful in maintaining tomato fruit quality and improving the shelf life. To assess its impact on tomato fruits, exogenous applications of six concentrations of melatonin were applied: 0, 0.1, 0.2, 0.5, 0.7, and 1 mM on Cobra 26, a hybrid variety broadly grown in Benin. Results indicated that melatonin reduced weight loss with the smallest value recorded with 0.2 mM and 1 mM. The highest proportion of marketable fruits 27 days after storage was also recorded at the same concentrations. The highest results were obtained with 0.1 and 0.2 mM of melatonin. Fruits treated with 0.5 mM presented the highest value of total soluble solids while no impact was recorded on the pH of fruits across all treatments. Melatonin has demonstrated promising and interesting results in tomato fruit preservation and could serve as an important method for producers to enhance both the quality and availability of fresh tomato fruits. However, several studies are still needed to investigate the physiological process behind melatonin's impact on tomato fruit quality.

Melatonin, shelf life, weight loss, fruit quality

PH52

Effect of melatonin combined with calcium chloride on the quality of fresh-cut ripe mango during storage

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This study evaluated melatonin and calcium chloride treatments for preserving postharvest quality of fresh-cut '*Namdokmai Sithong*' mango under cold storage. A completely randomized design with four treatments was used: control (distilled water), 1 mM melatonin, 1% calcium chloride, and 1 mM melatonin + 1% calcium chloride. Treated mango pieces were stored at 6 ± 2°C for 10 days. Quality was assessed every 2 days by measuring weight loss, colour (L*, a*, b*), soluble solids, acidity, vitamin C, carotenoids, phenolics, and browning. The combined melatonin and calcium chloride treatment significantly reduced quality deterioration compared to control by minimizing weight loss, colour changes, browning, and maintaining higher bioactive levels. This treatment synergistically preserved physicochemical, nutritional, and sensory properties, extending shelf life of fresh-cut mango.

Phytochemical treatments, minimal processing, shelf-life extension, nutritional quality

1-MCP delays the ripening of ‘Lamb Hass’ avocado after cold storage

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Avocado production in Spain has increased significantly in recent years. Although the main cultivated variety is 'Hass', 'Lamb Hass' is gaining interest to prolong the commercial season. Nevertheless, very little information is available on the postharvest behaviour of this cultivar. To prolong the commercialization of most avocado varieties, storage at temperatures close to 5.5ºC are recommended. Nevertheless, the ripening after storage depends on many factors such as variety and maturity at harvest. On the other hand, the application of 1-MCP has been reported to delay the ripening process that occurs after storage in some varieties. In this study, the quality of 'Lamb Hass' fruit treated or untreated with 1-MCP was evaluated during storage at 5.5ºC for up to 4 weeks, and during the followed shelf life at 21ºC. During the first three storage weeks at 5.5ºC, little changes were observed in the main physicochemical parameters, but in the fourth week a slight decrease in firmness and a darkening of the fruit were observed, with no differences between 1-MCP and control fruit. However, an important delay in ripening was observed by 1-MCP when the fruit were transferred to 21ºC after each week at 5.5ºC. Thus, control fruit underwent a drastic softening, until values of 3.8 N, after 4 days at 21ºC that followed one week of cold storage. The firmness loss in 1-MCP treated fruit during the shelf life was more gradual. The fruit reached similar values than control after 12 days at 21ºC that followed one or two weeks of cold storage. After three storage weeks these values were found after 8 days at 21ºC and no differences were shown between control and 1-MCP fruit during shelf life that followed four weeks of storage. 1-MCP delays ethylene-induced ripening that occurs after transferring the fruit from cold storage to shelf-life conditions.

Ethylene, firmness, colour, shelf life, quality, 1-metilcyclopropene

Physiochemical and sensory quality of ‘Rubinstep’ of different maturities

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In this study, we evaluated physiochemical and sensory effects of 1-Methylcyclopropene (1-MCP) post-harvest treatment on 'Rubinstep' apple fruit harvested at multiple time s in one season. The apple fruit was harvested at optimal harvest timing (OHT) and two weeks before and after OHT. For each harvesting time, the fruit were divided in two, and half was treated with 1- MCP and the other half remained untreated. After treatment, the apple fruit were stored at 4°C in regular atmosphere for 13 to 18 weeks. A semi trained panel evaluated the sensory properties of the apple fruit the day after cold storage. Different harvest timing resulted in different maturity after storage and impact ed both the physiochemical and sensory quality of 'Rubinstep'. Fruit treated with 1-MCP lost less firmness and acidity during storage compared to untreated fruit and the treated fruit was recognized by the taste panel. Effect of harvest time and 1-MCP treatment on sensory properties will be discussed.

Rubinstep, 1-MCP, harvest time, storage, sensory quality

Effect of preharvest calcium treatments on ‘Rojo Brillante’ persimmon quality

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Calcium (Ca) has been reported as one of the main nutrients related with flesh firmness as it is a constituent of the cell wall. The form the Ca treatment is applied can affect its mobilization, thus, affecting fruit quality. Information about the effect of different Ca treatments on fruit quality of 'Rojo Brillante' persimmon is scarce. In this study, different treatments based on Ca were applied in groups of three plants, and each treatment was replicated three times: 1) radicular Ca application (Ca-radicular); 2) radicular Ca application + boron by foliar application (Ca-radicular+B-foliar); 3) Ca + silicon by foliar application (Ca+Si-foliar). Four applications were performed at different plant phenological stages, from April to July. At the commercial harvest moment, the yield (number and weight of fruits) and the main fruit quality parameters (colour and firmness) were evaluated. It was also evaluated the concentration of macro and micronutrients on the flesh fruit, differentiating the apical zone from the basal zone. Trees treated with Ca-radicular showed the highest fruit number, but with lowest size, probably due to the high nutrient competition. This was because of this treatment on reducing fruit drop. Moreover, the firmness of Ca-radicular treated fruit exhibited the lowest values. Ca-radicular+B-foliar treatment induced a more intense orange colouration when compared to the control. Ca+Si-foliar treatment, without causing a detriment in the number of fruits, induced fruit with the highest weight and firmness and the lowest external colouration. Regarding the nutrient concentration, Ca and B concentration in fruit were modified due to the treatments, although only in the fruit apical zone. The treatments that received radicular Ca showed a higher concentration of this element. Similarly, fruit treated with B showed a higher B concentration, but only in the apical zone.

Firmness, micronutrients, physicochemical characteristics, radicular, foliar

Local handling of tree-bagged, hot water- and prochloraz-treated ‘Carabao’ mango from Davao to Manila, Philippines

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In the Philippines, the 'Carabao' mango is a high-value crop with a very good market; however, the variety is highly perishable and susceptible to pests and diseases. Effective preharvest and postharvest treatments are important to maintain fruit quality in the supply chain. In this study, the quality of tree-bagged (newspaper, Taiwan paper bag) and subsequently hot water- and prochloraz-treated 'Carabao' mango then transported over 1484 km distance from Davao del Sur to Manila was evaluated. Fruit were heat-treated (untreated; hot water treatment, 52-55°C for 5 min) and dipped in prochloraz fungicide (0, 550 mg L^{-1}). Fruit bagged with Taiwan paper bags consistently showed lower weight loss upon arrival in Manila and up to eight days of ambient storage compared to newspaper-bagged fruit. Hot water treatment increased weight loss throughout the storage, whereas prochloraz treatment (550 mg L^{-1}) showed lower weight loss at eight days. Taiwan paper bags resulted in better visual quality at harvest and during storage. Likewise, heat- and prochloraz-treated fruit had better visual quality during storage. Newspaper-bagged and heat-treated fruit showed faster peel colour change upon arrival in Manila and during storage. The use of Taiwan paper bags decreased the percentage of fruit affected with anthracnose (54.17%) and stem end rot, SER (21.67%) compared to newspaper bags (69.17% for anthracnose and SER for 42.50%). Both heated and non-heated prochloraz significantly reduced the percentage of fruit with anthracnose to 5% and 11.67%, respectively, compared to the control without treatments (66.67%). Tree-bagging of 'Carabao' mangoes with Taiwan paper bags, followed by postharvest treatments, such as hot water and prochloraz, show potential in maintaining better quality of mangoes, primarily due to reduced postharvest diseases.

Anthracnose, hot water treatment, stem end rot, visual quality

PH57

Characterisation of *Opuntia ficus-indica* mucilage-based films incorporated with encapsulated beetroot waste extract powder for potential postharvest preservation

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The development of sustainable packaging solutions is crucial for enhancing food preservation and safety while minimising environmental impact. This research focused on the formulation and characterisation of bio-based edible films composed of *Opuntia ficus-indica* mucilage (OFIM) and cellulose nanofibers (CNF) integrated with beetroot waste extract powder (BWEP) at 0%, 0.5%, 1%, 1.5% and 2%. Using the solvent casting method, the study investigated the impact of BWEP on the films' mechanical properties, physical characteristics, and pH sensitivity when exposed to ammonia vapours. Results indicated a pH-responsive colour transition in the films from red to yellow across pH levels from 1 to 13, suggesting potential applications in pH-sensitive packaging. Scanning electron microscopy and X-ray diffraction analyses showed that BWEP enhanced film compactness, and Fourier transform infrared spectroscopy indicated potential hydrogen bonding between betacyanins in BWEP and the OFIM-CNF matrix. The addition of 2% BWEP significantly ($p < 0.05$) increased moisture content (37.86%), water solubility (44.63%), and swelling capacity (3.06%), as well as antioxidant properties. Water vapour permeability of the films varied significantly, ranging from 0.39 g/MPa for OFIM-CNF-0% BWEP to 0.89 g/MPa for OFIM-CNF-2% BWEP. The film's sensitivity to ammonia was notable, with 1% BWEP showing the highest total colour difference, highlighting the feasibility of using the film for intelligent packaging applications. This study demonstrates that OFIM-CNF-BWEP film offers promising properties for developing functional packaging for postharvest and food preservation.

Sustainability, biodegradable, postharvest loss, circular economy, intelligent packaging

Broccolomics: Influence of postharvest temperature and irradiation on the vitamin C metabolism in broccoli flower buds

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Broccoli (*Brassica oleracea* L. var. *italica*) is one of the most popular vegetables world-wide, and a common meal component in a healthy diet. The flowering heads of broccoli are rich in vitamin C, with highest concentration in the green flower buds. The aim of this study was to explore the effect of postharvest temperature and irradiation on the metabolism of vitamin C in broccoli flower buds, using a multi-omics approach. Freshly harvested broccoli heads (cv. Ironman) were acclimated for four days at 4°C in total darkness, before storage for six days under the following conditions: 1) 4°C in darkness, 2) 10°C in darkness, 3) 10°C with visible light, and 4) 10°C with visible light and UV-B radiation. Irradiation treatments were conducted for 12 h per day. The effect of storage conditions was explored by three omics technologies, i.e. transcriptomics (microarrays), proteomics (LC-MS/MS) and metabolomics (LC-MS), in addition to quantitative analysis of vitamin C content (HPLC-DAD). Broccoli flower buds had higher vitamin C content after dark storage at 4°C than at 10°C. Also, exposure to visible light resulted in a higher vitamin C content than darkness or if combined with UV-B radiation during storage at 10°C. The multi-omics approach provided valuable insights into the metabolism of vitamin C in broccoli flower buds as influenced by temperature and irradiation during postharvest storage.

Postharvest storage, ascorbic acid, dehydroascorbic acid, transcriptomics, proteomics, metabolomics, multi-omics approach

PH59

Natural and modified zeolites as ethylene scavengers during postharvest life of perishable horticultural produce

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Several horticultural produces are sensitive to ethylene during storage and postharvest life. Storage protocols commonly involve interventions aimed at regulating fruit sensitivity to ethylene (e.g. 1-methylcyclopropene) or removing this gas hormone from the storage environment. Fruit industry is constantly searching for new, more effective and low Impact tools for ethylene adsorption. In this context, zeolites are natural microporous crystalline aluminosilicates with regular intracrystalline cavities and channel of molecular dimensions and represent good candidates both in its natural and chemically/physically modified forms. Indeed, its structure-property relationship can be adjusted to enhance its potential commercial applications as gas adsorber/scavenger for undesirable substances removal. Modified zeolites are prepared starting from the natural zeolite, which is composed of 85% clinoplilotite, 8% cristobalite, 4% illite and 3n4% plagioclast, with a Si/Al ratio of 4.8-5.5. This study examined the ability of different zeolite formulations (natural, ZeoNat; acidified, ZeoH; iron- or copper-modified, ZeoFe and ZeoCu) to adsorb ethylene and CO_2 gases. Among the tested zeolite formulations, ZeoH proved to be the one with the significantly higher adsorption capacity for both ethylene and CO_2. In two days of incubation of the zeolite with 10 ppm ethylene, ZeoH absorbed an average of 61% of the total gases, followed by ZeoCu (16%), ZeoNat (12%) and ZeoFe (10%). All tested zeolite formulations were shown to have higher affinity to ethylene than to CO_2. In this study, we also tested the effectiveness of zeolites formulations during the shelf-life of kiwifruit and the cold storage of blueberries. After three weeks of shelf-life, the kiwifruit stored in packages containing zeolite exhibited significantly higher firmness and lower soluble solids content. The ZeoH and ZeoCu formulations appeared as the most effective in delaying ripening. No significant differences were found between the blueberries stored with zeolites and the control group.

Ethylene, storage, shelf-life, packaging

PH60

Large-scale comparison of apple quality conservation of a direct CO_2 and an indirect propane refrigeration system

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After the adoption of the EU F-gas regulation aimed at phasing out HFC refrigerants due to their high global warming potential (GWP), commercial fruit storage facilities are mandated to transition to environmentally friendly alternatives. However, to date, there has been a lack of comprehensive studies conducted on a commercial scale comparing the alternative refrigerants CO_2 (R744) and propane (R290) regarding their suitability for apple fruit storage. In this project, new refrigeration systems were installed in identical storage rooms with a capacity of 50 metric tons, utilizing R290 (indirect evaporative cooling) and R744 (direct) as refrigerants. During harvest, both storage rooms were filled over 10 days with homogeneous fruit material from the same orchard and cooled to 1°C. Subsequently, controlled atmosphere (CA) conditions (1.0 kPa O_2 and 2.5 kPa CO_2) were established. Following an 8-month storage period, both rooms were opened simultaneously. To evaluate the potential of each refrigerant, the stability of climate control within the rooms was assessed and correlated with analyses of fruit quality. Samples from randomized positions in both storage rooms are currently being analysed for changes in key quality attributes, including firmness, titratable acidity, peel colour, total soluble solids, and mass loss. Evaluation is ongoing and expected to be completed in the coming months.

Storage, GWP, R290, R744, alternative refrigerants, fruit quality

Advancements in Post-harvest Preservation Techniques and Equipment for Leafy Green Vegetables

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China is one of the leading global producers of fruits and vegetables, but significant losses, estimated at 20%-30%, occur in the supply chain, resulting in economic losses of approximately 75 billion RMB. To address this, efficient and energy-saving preservation technologies and equipment have been developed by our team. Focusing on the 'first mile' of the supply chain, attention has been given to the challenges faced by leafy vegetables, which are prone to wilting, yellowing, and decay. A set of sterilization agents and equipment, along with usage standards for various varieties, has been created. Additionally, intelligent pre-cooling equipment with antimicrobial capabilities has been developed, reducing pre-cooling times and energy use by 50%, while extending shelf life by over 100%. Packaging materials with anti-fog, antimicrobial, and controlled atmosphere features have been designed, increasing shelf life by over 30%. Portable preservation cards have been introduced to delay the respiration peak of different varieties. In the 'last mile,' an intelligent cold storage control system with remote monitoring and a lighting system that inhibits senescence at the retail level have been implemented. The cold chain has been further enhanced with optimized logistics and distribution management, reducing transit losses to less than 5%.

Intelligent pre-cooling equipment, portable preservation card, intelligent cold storage control system, intelligent lighting system, logistics and distribution system

3D cloud point monitoring of purple carrots and golden kiwis during drying

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The persistent challenge of ensuring consistently high-quality processed fruits and vegetables is due to limitations in processing and preservation techniques. Despite being one of the most popular processing and preservation techniques, hot air drying is still a challenge due to unexplored hidden complex relation between process and product quality parameters. The dynamic drying process is complex and difficult to control. To resolve this issue, current research focuses on the study of variations in qualitative aspects during drying of purple carrots and golden kiwifruits. These variations are recorded and analyzed using non-invasive (3D imaging, Hyperspectral imaging (HSI)) and invasive techniques. Significant changes in color and moisture content were found using invasive approach. The results were further compared with 3D cloud-point and HSI (non-invasive) findings, which showed high correlation among moisture content and color pigments. 3D cloud point camera explored the physical changes like change in surface area or volume during shrinkage because of the drying process. Aligned with invasive color data, the 3D cloud point images exhibited chromaticity shift during the drying in terms of color changes, which indicated the pigment degradation due to heat exposure.

3D cloud-point, chromaticity, degradation, fruits, hot air drying, hyperspectral imaging, pigments, qualitative aspects, vegetables

PP1

Short antimicrobial peptides to combat *Botrytis* fungal pathogen and control 'Gray mould rot' disease in fruits

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Botrytis grey mould rot, which is caused by *Botrytis cinerea* in fresh horticultural crops is an important plant fungal disease in the global agricultural industry. *B. cinerea* causes extensive yield losses in nearly 1400 crop plants, resulting in huge economic impacts worldwide. It is estimated that the financial impact of grape crop losses from *B. cinerea* is up to US$ 2 billion annually and it is the major pathogen in the wine industry. The agriculture and food industries mainly depend on synthetic chemical fungicides to control fungal pathogens. As chemical fungicides have threatened food safety and caused escalation of pathogen resistance, this work evaluated antimicrobial activity of short peptides, which are a natural defence mechanism of some living cells, against this fungal pathogen. Bioassays were conducted for four types of Battacin analogue and two types of PAF32 peptide on different life stages of *B. cinerea*. Mycelial growth was completely suppressed by 6.25 µM/L of BX peptide and spore germination was completely inhibited by both BD and BX peptide at 12.5 µM/L. SEM and TEM images clearly show sunken, distorted, and shrunken spores and mycelia due to cell leakage from disruption of cell membranes by these peptides. BX increased ROS levels significantly in pathogen cells at low concentrations after 24 hours exposure and thus may cause an oxidative burst which kills the pathogen cells. Both AMPs may effectively cause cell lysis of the pathogen through disrupting membrane permeability and creating cellular toxicity in *Botrytis* fungal mycelium and spores. These peptide analogues may alter negatively charged lipopolysaccharidesand anionic lipids, thus affecting cell membrane polarity. These two Battacin antimicrobial peptides show promise for effective control of *B. cinerea* to protect agricultural crops.

Botrytis cinerea, antimicrobial peptides, grey mould rot disease

PP13

Unveiling the impact of postharvest treatment with *Aureobasidium* sp. isolate TCY70 on the microbiome of citrus fruit

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The yeast-like fungus *Aureobasidium* sp. shows great potential on controlling postharvest diseases of fruits. Our preliminary data have showed that *Aureobasidium* sp. TCY70 effectively reduces the incidence of postharvest diseases in citrus fruits. In this study, we investigated the variation in the microbiome on the epiphytic surface of citrus fruit during storage following the application of *Aureobasidium* sp. TCY70. Our results revealed a significant shift in fungal diversity compared to bacterial diversity in the microbiota after treatment with TCY70. In the treatment group, *Aureobasidium* sp. was enriched, while *Cladosporium* sp., *Aspergillus* sp, and *Penicillium* sp. were depleted compared to the control group. After one month of storage, *Aureobasidium* sp. remained enriched in the treatment group at 24.4%, whereas *Penicillium* sp. was present in a lower proportion than the control group. These findings indicate that the application of *Aureobasidium* sp. TCY70 inhibited the growth of postharvest pathogens in citrus, providing an advantage to *Aureobasidium* sp. within the fungal microbiota. This is evidenced by significantly lower Shannon index values in the treated samples, indicating reduced richness and diversity post-treatment. Interestingly, there was no observable effect on the variation of bacterial microbiota after treatment with TCY70. Therefore, based on the microbiota response to TCY70 treatment, it suggests the potential to reduce fruit rot caused by *Penicillium* sp. and provides evidence of *Aureobasidium* sp. TCY70's effectiveness in managing postharvest diseases in citrus.

Aureobasidium sp., microbiome, citrus, postharvest diseases

PP14

Orange oil postharvest fruit application against *Botrytis cinerea*

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Orange oil is a naturally occurring product that is known for its antibacterial properties in the food and pharmaceutical industry, but literature on postharvest fruit applications is scarce. The aim of this study was to investigate the efficacy of the dip application of orange oil against *Botrytis cinerea* on plums and strawberries by evaluating the curative and protective actions, incubation time and exposure time in the bath. Orange oil only, orange oil-based formulations were evaluated and compared with the standard practice of fludioxonil application at the recommended dose. The concentration of orange oil was adjusted to obtain a range of 0.05% to 0.10%, 0.50% to 1.00%. On plums, orange-only oil treatments resulted in 40 to 37% disease incidence, from lowest concentration to highest concentration, showing a decreasing level of disease incidence with increasing the concentration. Both formulated treatments also resulted in a significantly reduced level of disease incidence from 54 to 33% and 57 to 36%, respectively. When plums were treated and followed by inoculation 3 h later (protective treatments), the untreated control resulted in an 80% level of disease incidence, which was reduced to 57% in the standard fungicide (fludioxonil) treatment. Orange oil-only treatments on strawberries resulted in a mean disease incidence of 48% in the 0.1% orange oil concentration and 53% incidence in the 1.0% orange oil concentration. On day 14, the incidence of grey mould was reduced from 82% of the untreated control to 55%, 21%, and 44% on the two formulated products, and orange oil only treatments, respectively. When the fruit was left at ambient for further 3 days, it became severely infected with grey mould. This study showed that orange oil presents a promising active ingredient as alternative postharvest biofungicide to protect stone fruit and berries from grey mould infection.

Dip application, Grey mould, Orange oil

PP18

Fungal complexes associated with postharvest superficial mould of pome fruit

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The presence of superficial mould on the pedicles and calyx sepals of pome fruits after controlled atmosphere storage poses a significant challenge in export markets, often leading to costly repackaging or outright rejection of consignments. This research aimed to identify the fungi associated with this condition and determine whether these fungi occur in complexes rather than individually. Fungal samples were collected from symptomatic apple and pear fruits obtained from commercial packhouses in South Africa's Western Cape Province. Molecular techniques were employed to identify the fungi present. Gene regions Alt-a1 and OPA1-3 were targeted for *Alternaria* species identification. Notably, the OPA1-3 gene region, analyzed with the enzyme ApaI, facilitated discrimination between *A. arborescens* and *A. alternata/A. tenuissima*. Additionally, gene regions TEF1 and RPB2 were utilized to identify other fungal genera. PCR-RFLP analysis revealed that among 100 fungal isolates from apples, 31 were identified as *A. arborescens* and 27 as *A. alternata/A. tenuissima*, while among the 13 pear isolates, five were *A. arborescens* and eight were *A. alternata/A. tenuissima*. Furthermore, PCR targeting TEF1 and RPB2 amplification identified nine isolates as *Cladosporium cladosporioides* and nine as either *Epicoccum nigrum* or *E. layuense*. Importantly, these three genera were frequently co-isolated from the calyx and stem of the fruits. Additionally, other fungal genera including *Diplodia*, *Aureobasidium*, and *Fusarium* were identified, albeit at lower frequencies. In summary, various fungi were identified as the causative agents of stem and calyx mould on pome fruits stored under long-term controlled atmosphere conditions. It's noteworthy that these fungi occur in complexes rather than individually. Understanding these complexes and the epidemiology of the constituent members will be crucial in developing effective management strategies.

Fungal complexes, Alternaria spp, Cladosporium spp, Epicoccum spp

PP19

First report of phytopathological problems during ginger post-harvest season

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Peru is one of the main ginger exporting countries to the USA, Canada, and Europe; according to ADEX, in 2022 Peru was ranked as the third exporting country in terms of export value, which was 63.08 million dollars. The production is organic and the production fields are located mainly in the Central Jungle (Provinces of Chanchamayo and Satipo in Junin, Peru), whose climate and soil conditions favour the good development of the crop and the exportable product. The export product is the rhizome, which is a vegetative structure that develops in the soil. Therefore, unlike an exportable fruit, in which the phytopathological nature of the postharvest problems is related to molds such as *Botrytis* or *Penicillium*; in the case of ginger, these causal agents are more related to the phytosanitary problems that develop during cultivation, such as soil pathogens. To date, there is no record of post-harvest problems with ginger in Peru. Therefore, the objective of this research was to carry out a diagnosis of the health problems in ginger post-harvest handling. During the years 2022 and 2023, samples of rhizomes with rot symptoms (from packinghouse discard) were taken. A characterization of the different symptoms detected was made; according to the name assigned by the producers: "blackfoot", "black spots", "soft rot", "silver", "nodules". The samples were washed with drinking water; disinfested with 70% ethyl alcohol. Sections of diseased tissue were plated in Petri dishes containing the culture medium PARB, PDA, AN. The plates were incubated at 25°C in the dark for one week. The following microorganisms were isolated: *Rosselinia*, *Rhizoctonia solani*, *Pythium* and *Pectobacterium*. The microorganisms were purified, and increased for pathogenicity tests. The inoculation method was done by pouring the purified microorganism on the base of ginger plants under semi-controlled greenhouse conditions. Results were positive for Koch's third postulate.

Ginger post-harvest rot, rot rhizomes, Rosselinia, Pyhtium, Pectobacterium

PP21

The essential oils as biofungicide against strawberry *Colletotrichum acutatum*

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Colletotrichum spp., which causes strawberry anthracnose, reduces yield by more than 50% and can cause up to 80% losses in nurseries. In 2030, the EU aims to reduce the usage of chemical pesticides by 50%. Therefore, plant protection focuses on environment-friendly alternatives. Essential oils contain valuable compounds that have the potential to serve as alternative plant protection due to antifungal and antimicrobial activity. The research aimed to evaluate strawberry postharvest treatments with different essential oils concentrations as a biofungicide against strawberry C. acutatum. For this study, we selected essential oils of Thymus vulgaris (concentration 50 and 100 µL/L), Mentha piperita (1400 and 1800 µL/L) and Salvia officinalis (1400 and 1800 µL/L). Strawberry fruits treated with different concentrations of essential oils and inoculated with C. acutatum. Disease incidence (%) was evaluated 2, 4, and 8 days post-inoculation (DPI). The results revealed that at 4 DPI, the lowest C. acutatum disease incidence was in S. officinalis 1400 µL/L (1.15%) and T. vulgaris 50 µL/L (2.60%). In the inoculated control, C. acutatum disease incidence was 15.79% 4 DPI and 63.46% 8 DPI. The C. acutatum disease incidence 8 DPI also lowest was in S. officinalis 1400 µL/L (19.17%) and T. vulgaris 100 µL/L (21.67%). However, at 4 and 8 DPI, C. acutatum incidence in M. piperita for 1400 µL/L was 3.33% and 37.50%, respectively, and for 1800 µL/L concentration was 3.75% and 31.25%. Data indicated that essential oils reduced strawberry postharvest rots caused by C. acutatum. This study provides the basis for further research on developing an effective biofungicide to control strawberry postharvest C. acutatum. This project has received funding from the Research Council of Lithuania (LMTLT), agreement No [S-NORDFORSK-23-6].

anthracnose, Mentha piperita, Salvia officinalis, Thymus vulgaris

Preharvest treatment with alternative plant protection products to control strawberry postharvest decay

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Plant diseases cause yield and postharvest losses if not treated early in the production cycle. *Botrytis* spp. causes yield losses ranging from 15% to 50%. There is a demand for alternative plant protection against diseases because chemical pesticides cause pathogen resistance and have other adverse effects. Postharvest storage also depends on preharvest treatments. Research aimed to evaluate strawberry preharvest treatments for yield and postharvest decay. Experiments were conducted in a tunnel greenhouse with two strawberry cultivars, 'Elsanta' and 'Sonsation', and grown in plastic pots (3 liter, 19x15) containing peat substrate (Terraerden, Rucava, Latvia) with NPK (100-160; 110-180; 120-200 mg L^{-1}) and microelements Mn, Cu, Mo, B, Zn and Fe (pH H_2O 5.5-6.5; electrical conductivity (EC) ms cm^{-1} < 1.10). Plants were watered when needed, and placed in randomised blocks, with four replicates. The first application was at 10% flowering (BBCH 61-65) and repeated every 7-10 days (a total of four times). Applications: 1) Control - untreated; 2) Bacterial - treatment with a mix of *Bacillus velezensis* and *B. halotolerans*; 3) Essential oil - treatment with *Thymus vulgaris* essential oil. The first results with bacterial and essential oil treatment showed promising results. Yield in control treatment in 'Elsanta' was 6.30 kg/plot, and in 'Sonsation', 8.36 kg/plot. The highest yield in 'Elsanta' was in bacterial treatment at 7.78 kg/plot. In 'Sonsation', a higher yield was in essential oil (8.22 kg/plot) than in bacterial (7.45 kg/plot) treatment. The results revealed that 8 days after postharvest storage, the percentage of infected fruits in essential oil was 60.00% and bacterial 44.00% in 'Elsanta' and in 'Sonsation' 18.98% and 33.28%, respectively. According to our preliminary results, it can be assumed that alternative plant protection has the potential to control *Botrytis* spp. This project has received funding from the Research Council of Lithuania (LMTLT), agreement No [S-NORDFORSK-23-6].

Botrytis spp., Fragaria x ananassa, grey mould

PP23

Nitrogen effects on *Alternaria* spp. growth *in vitro*

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It is known that mineral nutrition affects leafy vegetable growth. However, how it affects postharvest storage and plant pathogens remains questionable. *Alternaria* spp. is an important pathogen causing plant disease and postharvest loss. The leafy vegetable growth conditions influence postharvest shelf-life and prolong postharvest storage depending on handling temperature and technological treatments. This study aimed to evaluate *Alternaria* spp. infection spread at different nitrogen nutrition levels. Treatments in vitro : 60 ppm nitrogen (N), 90 ppm N, 120 ppm N and 150 ppm N concentrations. The *Alternaria* spp. a 7 mm mycelium disk, was placed in the centre of PDA with different N concentrations. Incubated 22°C in darkness and assessed after 2, 4, and 7 days (DPI). The results showed that *Alternaria* spp. growth was lowest at 120 and 150 ppm N at 2 DPI and highest at 60 and 90 ppm N. The growth of *Alternaria* spp. at 4 DPI was similar in all concentrations; however, at 5 DPI, *Alternaria* spp. growth was like the 2 DPI. According to our preliminary results, it can be assumed that the nitrogen concentrations affect *Alternaria* spp. growth. This project has received funding from the Research Council of Lithuania (LMTLT), agreement No S-MIP-23-20.

Leafy vegetable, nitrogen, concentration, growth

PP25

Exploring the effect of electrolyzed water against brown rot disease (*Monilinia* spp.) on peach fruits

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Brown rot caused by several species of *Monilinia* genus, stands as one of the most significant diseases affecting stone fruit globally. However, over the past decade, *M. fructicola* has emerged with high prevalence in numerous countries, including Greece. Consequently, the losses incurred due to *Monilinia* spp. remain a primary concern for growers, industry stakeholders, and agricultural researchers given their detrimental impact on both pre- and postharvest phases of peach production. The aim of this study was to evaluate the effectiveness of postharvest application with electrolyzed water (EW) to reduce the losses occurred by *M. fructicola* in peaches. In detail, we evaluated the effect of several types of EW (pH 7.6, pH 8.6, and pH 9.6) and immersing duration, on the development of *M. fructicola* after artificial inoculation. Commercial harvested peaches (cv. Andross) were surface sterilized (2 min, 3% NaClO), and artificially inoculated with *M. fructicola* conidial suspension (4 x 10^5 conidia ml^{-1}). Artificially inoculated fruits were immersed in EW solutions for 10 min in different hours post the inoculation (8, 12 and 24 hpi). Subsequently, the fruits were transferred to plastic container (to ensure high humidity levels), and incubated for 7 days at room temperature. Results revealed that applications with EW 8 hpi, significantly reduced the disease severity, while no significant differences were observed among the tested pH levels. Similar results were obtained 12 and 24 hpi, however the fruits treated with EW (pH 7.6) presented higher disease severity compared to the control, while application with EW with pH 8.6 and 9.6 considerably reduced the disease development. Acknowledgment: This work was funded by the European Union-Next Generation EU, Greece 2.0 National Recovery and Resilence plan. Project title Electrolyzed water: A green innovation for the management of brown rot in stone fruits (M16ΣΥΝ2-00088).

Monilinia fructicola, stonefruits, control, postharvest losses, brown rot disease

PP33

AaRgss differential regulate fungal development, stress response and appressorium-like formation in *Alternaria alternata*

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Alternaria alternata, the causal agent of black spot disaese in pear fruit, can recognize and respond to physichemical cues from the pear surface through a complex signaling network to induce infectious structures formation, and then form infection hyphae to invade the fruit through the lenticels or intact epidermis, resulting in black spot disease. Heterotrimeric guanine-nucleotide binding protein (G-protein) signal transduction pathway play a prominent role in the process that eukaryotic cells perceive surrounding environment cues and regulating intracellular biological processes. As a negative regulator of G protein signaling (RGS), RGS have important roles in regulating cellular processes in biological organisms, especially have been characterized in several model fungi, but its biological function in *A. alternata* remains unclear. Three RGS proteins were identified in *A. alternata* by Blast alignment and designed as AaRgs1, AaRgs2 and AaRgs3. Targeted genes deletion demonstrated that AaRgs1 and AaRgs2 play the opposite function in vegetative growth, melanin production and secretion, stress response and appressorium-like formation rate in *A. alternata*, while AaRgs3 had no certain regulatory effect. Differently, AaRgs1 negatively regulated tolerance to high-osmosis stress response and cell wall synthesis inhibitors by down regulating the expression level of AaHog1 and AaSlt2. AaRgs2 acts as a negative role in regulating appressorium-like formation rates through decreasing intracellular cyclic adenosine monophosphate (cAMP) accumulation. Deletion of AaRgs1 and AaRgs2 also resulted in significantly reducing penetrating ability and pathogenicity. The findings indicated that RGS proteins play diverse roles in fungal development, stress response and appressorium-like formation of *A. alternata*.

Regulator of G protein signaling (RGS), Alternaria alternata, cuticular wax, infectious structures formation, pear fruit

Ozone treatment inhibited the blue mold development and maintained the main active ingredients content in *Radix Astragali* infected by *Penicillium polonicum* by activating ROS metabolism

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Penicillium polonicum is the main pathogen causing the blue mold in postharvest fresh *Radix Astragali* (RA), whose infection not only leads to the postharvest diseases, more importantly, which metabolizes patulin (PAT) in fresh RA tissue, seriously threatening human health. Ozone application effectively managed the postharvest diseases in fruit and vegetables. However, there are few researches on the controlling the postharvest diseases and maintaining main active ingredient content in fresh Chinese traditional medicine by ozone treatment. In this study, the spore suspension of *P. polonicum* was inoculated by spraying on fresh RA to investigate the control effect of ozone on postharvest diseases of RA, analyze the change of the main active ingredient content, and study the effect of ozone on reactive oxygen species (ROS) metabolism in RA. The results indicated that 2 mg L^{-1} ozone application significantly inhibited the development of blue mold caused by *P. polonicum*, and controlled the PAT accumulation by activating the ROS metabolism and enhanced the antioxidant enzymatic activity, which thus avoided oxidative damage caused by excessive ROS accumulation, and maintained the integrity of cell membrane, ultimately controlled the occurrence of blue mold in RA. Moreover, ozone treatment also maintained the contents of main active ingredients in RA before 14 days, the active ingredients of astragaloside I, calycosin-7-glucoside and ononin in ozone-treated group were higher than those in control group during storage period, we speculate that under the action of ozone, astragaloside IV was converted into astragaloside II by oxidative modification, and astragaloside II was further oxidized to astragaloside I, resulting in the accumulation of astragaloside I. Similarity, the hydrogen atoms (-H) on the benzene ring in formononetin were oxidized to phenolic hydroxyl groups (-OH) to generate calycosin, which was further converted into calycosin-7-glucoside, resulting in calycosin-7-glucoside accumulation. The study will provide a theoretical basis for ozone commercial application to control the occurrence of postharvest diseases of RA.

Radix astragali, Penicillium polonicum, patulin, ozone, active ingredient, postharvest diseases

PP37

Re-establishing the Australian sesame industry: detection and identification of sesame seedborne fungi from target production sites

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Sesame (*Sesamum indicum* L.) is one of the oldest oilseed crops, cultivated in tropical and subtropical regions of Asia, Africa and South America is a rich source of oil, protein, calcium and phosphorus. In the 90's the attempt to establish a sesame industry in Australia failed. With Australia strategically positioned geographically to enter sesame production, an attempt was initiated in 2018 to re-establish the industry through the introduction of high-yielding, non-shattering sesame lines which could be harvested mechanically. However, different disease-causing pathogens affect the sesame crop, including some post-harvest and storage fungi causing serious losses in production. These seedborne fungi cause damage by reducing seed quality and their germination, while infected germinated seeds do not grow properly, increasing the chance of seedling death and pre- or post-emergence diseases. With target production sites in Australia already identified, the present investigation aimed to identify the seedborne fungi associated with harvested sesame seeds. For this purpose 23 seed samples were collected based on site, year of planting, season of planting and seedcoat colour, then seeded on agar plates to allow fungal growth. Through sequencing of the Internally Transcribed Spacer (ITS) region, the different seedborne fungi were identified to belong to the following genera: *Alternaria*, *Aureobasidium*, *Bipolaris*, *Chaetomium*, *Cladosporium*, *Curvularia*, *Epicoccum*, *Exserohilum*, *Fusarium*, *Lasidiodiplodia*, *Macrophomina*, *Nigrospora* and *Spegazinia*. Moreover, differences were observed in the seedborne fungi detected and their prevalence based on site, year of planting, season of planting and seedcoat colour. Such information will serve as guide in preventing spread of sesame diseases and in developing strategies to manage these seedborne fungi to minimize sesame crop yield losses.

Seed-associated mycoflora, universal primers, BLAST

Detection of *Colletotrichum karsti* and *C. truncatum* causing anthracnose of melons in Hondur

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During the 2019-2020 season, unusual rains occurred in southern Honduras that affected melon crops destined for export. Development of necrotic, circular and depressed lesions on the fruits, with dark margins, characteristics of anthracnose were observed. In postharvest, the apparently healthy harvested fruits developed surface depressions and cavities with mycelium in the pulp. Direct observation of infected samples allowed us to determine the presence of at least two species of *Colletotrichum*, according to the morphology of their conidia. Isolations were carried out in PDA and casitone yeast extract agar to observe mycelial growth and the development of acervuli, conidia and conidiophores. Two morphotypes were observed, from which monosporic cultures were made in PDA medium, for further molecular identification. A multilocus phylogenetic analysis with the partial sequences of ITS, gadh, tub2, his, act and chs was conducted. The isolates were identified as *Colletotrichum truncatum* and *Colletotrichum karsti*. Pathogenicity tests were carried out by inoculating healthy melon fruits, using two isolates per species, reproducing the symptoms and successfully reisolating the corresponding pathogen, complying with Koch's postulates. The study constitutes the first report of *C. truncatum* and *C. karsti* and of the *truncatum* and *boninense* complexes in the crop, since previously melon anthracnose had only been associated with *C. orbiculare*, *C. fructicola*, *C. aenigma* and *C. chlorophyti*.

Postharvest diseases, Cucumis melo, multilocus phylogenetic analysis, boninense complex

PP42

The multi-copper oxidase synthesis gene PdFET5 plays an important role in the infection of citrus by *Penicillium digitatum*

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Green mold caused by *Penicillium digitatum* is a major postharvest disease of citrus, causing a significant decrease in citrus quality and market yield. This study aims to understand the molecular mechanism by which the multi-copper oxidase synthesis gene PdFET5 in the RIA pathway regulates the pathogenicity of *P. digitatum* during citrus fruit infections, which can provide valuable insights for developing novel methods to control postharvest diseases in citrus fruits. We generated knockout (ΔPdFET5) and complementation (cPdFET5) strains of *P. digitatum* by knocking out and reintroducing the PdFET5 gene. We compared their in vitro growth and pathogenicity to the wild-type (WT) strain. While the ΔPdFET5 mutant displayed no significant morphological differences from the WT, it exhibited a significantly reduced colony diameter, mycelial dry weight, and spore production. In addition, the relative inhibition rate of ΔPdFET5 to Fe+ stress was significantly increased, and the tolerance was reduced, indicating that *P. digitatum* relies on RIA pathway to maintain iron homeostasis. Citrus fruit infections with the ΔPdFET5 mutant showed that the decay diameter was significantly smaller than the WT, suggesting that PdFET5 plays a crucial role in the pathogenicity of *P. digitatum*. The complementation of PdFET5 (cPdFET5) restored the hyphal growth, spore production, and pathogenicity to the levels of WT. These findings strongly suggest that PdFET5 is essential for the development and virulence of *P. digitatum*.

Penicillium digitatum, postharvest disease, citrus, knocking out, PdFET5 gene

PP45

Influence of hazelnut microbiome on kernel disease resistance

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The plant microbiome can influence its resistance to various stresses, such as fungal diseases, which are a serious concern for hazelnut yield and storage. The influence of the microbiome of Italian varieties of *Corylus avellana* L. on their resistance to postharvest diseases was investigated. The kernels of young hazelnut plants, to which the beneficial microbes had been applied in the nursery, were artificially inoculated with fungal pathogens (*Alternaria alternata*, *Botrytis cinerea*, *Fusarium lateritium* and *Phomopsis oblonga*, syn. *Diaporthe eres*) to assess the disease development. The results showed that the susceptibility of hazelnut kernels to the selected pathogens was influenced by the previous treatment with beneficial microbes, in particular, mycorrhizal fungi and *Trichoderma*. Next-generation sequencing revealed that the composition of root-associated fungal communities was different in plants treated with beneficial microbes compared to control plants, which were more susceptible to kernel fungal diseases. These results suggest that treatments with beneficial microbes may contribute to changes in the hazelnut root microbiome and increase plant resistance to fungal pathogens affecting kernels. Therefore, the integration of treatments with beneficial microbes into hazelnut nursery management not only improves plant growth performance and microbial diversity but also increases plant stress resistance, particularly to fungal diseases, thus fostering sustainable hazelnut cultivation systems.

Hazelnut disease resistance, fungal pathogens, plant microbiome, mycorrhiza, Trichoderma

PP47

Apple wet core rot postharvest management

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In South Africa, the majority of apple wet core rot (WCR) caused by *Penicillium* species infect fruit at both the pre-harvest and postharvest stages. Apple cultivars such as 'Fuji' and 'Top Red' are considered to be more susceptible to infection due to their open calyx which serves as an entry point for pathogens. Recent industry reports have identified a new group of pathogens causing apple WCR and it is thus important to identify and characterise the new causal agents and investigate appropriate management strategies. 'Fuji' apples were sampled from four orchards of known WCR incidence (1-3%) in the Grabouw/Villiersdorp region of the Western Cape, South Africa during the 2023 production season. Fruits were evaluated for WCR symptoms and isolations from the lesions were plated onto PDA + media followed by DNA extraction and PCR amplification using ITS and TEF1 to confirm species identity. Fungicide drench trials with registered fungicides fludioxonil and pyrimethanil and storage trials were conducted at 25°C and -0.5°C to evaluate efficacy of current management practices to control wet core rot. Fludioxonil effectively controlled wet core rot, while pyrimethanil did not. Furthermore, cold storage effectively inhibited fungal growth in inoculated apples. These results will contribute to the development of appropriate management strategies for wet core rot causal pathogens.

'Fuji', 'Top Red', Wet core rot, fungicide drench

PP48

Dry lenticel rot – an emerging postharvest disease on apples in northern Italy: insights from inoculation assays

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Ramularia mali, an emerging postharvest pathogen affecting apples is causing concern due to the increasing cases since 2017. In contrast to the asymptomatic nature of the fungal infection in the field, symptoms of the disease appear on apples only after extended storage in cold storage facilities. The initial occurrence of *Ramularia* spots, also known as dry lenticel rot, was observed in 2012 within the northern Italian region of Piedmont and the province of South Tyrol. Recently, occurrence of the symptoms has been reported from other apple growing areas in Austria and France. The aim of this study investigates the pathogen's behaviour through inoculation assays, using three different methods (injection, puncture wounds, immersion) and subsequent storage for 3 months. Two fungal isolates, one isolate originating from symptomatic fruits of the cv. 'Golden Delicious', and one from the *Ramularia mali* type culture (CBS:129581) were used to inoculate apple batches at harvest time, as well as 5 and 7 months after harvest. Symptom development occurred in 100% of infections by injection of the conidial suspension. Wounding of the apple cuticle by puncturing with a sterile needle showed symptoms in 94% of the apples after 7 months of postharvest storage. However, no symptoms were observed in fruits at harvest time and after 5 months of storage. Immersion into conidial suspension showed no symptoms under all tested conditions. These findings contribute to a better understanding of the dry lenticel rot symptoms' development and pave the way for further investigations in the storage of apples.

Ramularia mali, Malus domestica, pathogen

PP49

Postharvest fungal decay of tomatoes in the Western Cape

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Tomatoes are a commodity with relatively short shelf-life. Despite this, little is known about the fungal pathogens that contribute to tomato decay in South Africa. A postharvest assessment of tomato disease incidence, severity and pathogen identity was conducted on tomatoes grown in the Western Cape. Over two years (2022, 2023), tomato varieties ('Round', 'Roma', and 'Rosa') were sampled from across five regions in the Western Cape. Disease symptoms were visible on tomatoes as early as a few hours post packing in some regions. For others, symptoms appeared from week one and increased exponentially over four weeks. Disease incidence differed significantly between regions and years ($P \leq 0.05$) for each of the tomato variety assessed. Isolated pathogens fall under the following genera: *Alternaria* spp., *Stemphylium* spp., *Fusarium* spp., *Cladosporium* spp., *Geotrichum* spp. and *Penicillium* spp. The results showed that disease incidence peaks two weeks postharvest. A wide variety of fungal pathogens was detected, some of which pose a possible health concern for the public.

Disease incidence, fungal pathogens, tomatoes

PP50

Evaluation of nitrogen effect on *Botrytis* spp. development

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Nowadays, it's essential to preserve leafy vegetables after harvest and reduce postharvest losses. Mineral nutrition has a direct impact on leafy vegetable yield and, in addition to its postharvest shelf-life. During growth and postharvest, leafy vegetables are exposed to various plant diseases. Mineral nutrition affects plant pathogen's disease severity and susceptibility. This study aimed to evaluate *Botrytis* spp. the infection spreadsat different Nitrogen levels. The mycelial growth was evaluated at 60 ppm nitrogen (N), 90 ppm N, 120 ppm N and 150 ppm N concentrations. The single-spore *Botrytis* spp. fragment was placed in the centre of PDA with different N concentrations. Plates incubated at 22°C in darkness and evaluated after 2, 4, and 7 days (DPI). The highest *Botrytis* spp. growth was 60 ppm N, and the lowest was 90 ppm N after 2 DPI. However, after 4 DPI, the highest *Botrytis* spp. growth was at 90 ppm N and lowest at 60 ppm N. The conidia size (width and length) varied during treatments. The conidia width and length at 90 ppm N were the lowest. Similar conidia width and length were at 150 ppm N. The highest conidia size was at 60 ppm N in width and length. The results demonstrated that *Botrytis* spp. acts differently at different N concentrations. This raises questions about how mineral nutrition and fungal pathogens interact. This project has received funding from the Research Council of Lithuania (LMTLT), agreement No S-MIP-23-20.

Grey mould, mineral nutrition, conidia, growth

PP56

Antifungal activity of ethylicin against *Penicillium expansum*

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Ethylicin is a green broad-spectrum biomimetic fungicide first developed in China, capable of controlling a wide range of plant diseases. *Penicillium expansum* is a pathogenic fungus causing blue mold on various postharvest fruits such as apples and pears. In this study, we determined the inhibitory effect of ethylicin on *P. expansum*. The results revealed that ethylicin treatment inhibited the growth, spore germination, sporulation and altered the mycelial morphology of *P. expansum*. The expression of the patulin biosynthetic gene cluster and the gene expression of transcription factors PacC, LaeA, and CreA were downregulated in the ethylicin-treated *P. expansum* strain, along with a reduction in patulin production *in vivo* and *in vitro*. Furthermore, ethylicin treatment downregulated the activity of cell wall degrading enzymes and diminished the lesion diameter of fruits inoculated with *P. expansum*. Additionally, ethylicin affected the autophagy process of *P. expansum*. These results indicated that ethylicin can effectively inhibit the growth of *P. expansum* and attenuate the development of blue mold in fruits.

Penicillium expansum, ethylicin, antifungal activity

Effect of Betel leaf extract as an eco-friendly `green fungicide´ on the control of stem-end rot disease and overall quality retention of Papaya (*Carica papaya* L.) during cold storage

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Stem-end rot an important postharvest fungal disease in papaya fruit is caused by *Lasiodiplodia theobromae* (synonym *Botryodiplodia theobromae*). Betel leaves, *Piper betle* L., widely available in Malaysia and the Asian region, has been known for its antifungal and antimicrobial activities due to its bioactive chemical constituents. 6%, 8%, 10%, and 12% concentrations of Betel leaf propylene glycol extract (BLPG) and Betel leaf ethanol extract (BLET) were tested for their antagonistic potential against *L. theobromae*. Maximum inhibition in radial mycelial growth 98.48% and 93.67% of the pathogen was observed in 12% Betel leaf ethanol extract (BLET) and 12% Betel leaf propylene glycol (BLPG) extract respectively, as compared to the control. Maximum spore germination inhibition 93.2% was observed in 12% BLET. Scanning Electron Microscopy (SEM) images revealed that morphological changes in fungal hyphae and fungal conidial spores and complete cell lysis, with 10% and 12% of Betel leaf extract. *In vivo* studies show that, percentages of disease Incidence and disease severity of coated papaya, 'Sekaki' during 28 days of cold storage (10 + 2°C, 80% RH), is significantly low in coated fruits with Betel leaf extract as compared to the control. Assessment of weight loss, colour development, firmness, soluble solids content (SSC), titratable acidity (TA) and antioxidant level (Ascorbic acid and Lycopene content) of the fruits during the cold storage at 10 + 2°C (RH 80%) period was initially conducted at regular intervals for 28 days. Significant increase ($p < 0.05$) in the SSC, TA and antioxidant amount of papaya was observed in response to the treatment with edible coating BLET and BLPG, along with delayed firmness loss. In conclusion, Betel leaf ethanolic extract can be fruitfully utilized as an eco-friendly "green fungicide" to reduce stem-end rot disease at 12% concentration and extend quality and shelf-life of papaya in cold storage, thus minimize the postharvest economic loss.

Green fungicide, Lasiodiplodia theobromae, piper betle, betel leaf extract, carica papaya, stem-end rot disease

PP71

Variability of postharvest pyrimethanil effects on decay during and after storage of ‘Fuji’ apple

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The study evaluated the effects of postharvest treatment with the fungicide pyrimethanil (9.6 g a.i. tonne^{-1}) on apple fruit decay. Four experiments were performed under large-scale commercial storage conditions using 'Fuji' apples grown in Southern Brazil. In Experiments 1 and 2, fruit harvested in early and advanced maturity were stored in a controlled atmosphere (CA, 1.2 kPa O_2 < 0.5 kPa CO_2, 0.8ºC) for 240 days. In Experiments 3 and 4, the fruit were stored in CA for 150 days and in the air for 105 days, respectively. In each experiment, fruit samples from 3 to 10 orchard plots were collected from bins of commercially harvested fruit. Ten fruit samples of approximately 400 kg each (bins) were used for fruit assessment after storage for each orchard plot. Within 7 days after harvest, half of the samples from each orchard plot were treated with the fungicide in commercial storage facilities using thermal fogging (ActiMist&trade) for 24 h. After storage, one subsample of 100 decay-free apples was selected from each sample and held at 22ºC for a seven-day shelf life. The remaining fruits were assessed for the incidence of decay immediately after storage (day 0). The average incidence of total decay from each experiment ranged from 4.5% to 18.7% after storage and 19.5% to 38% after the shelf life for control fruit. Bull's-eye rot was the main rot symptom in three of the four experiments, followed by blue mold, gray mold, and moldy core rot after storage. After the shelf life, the predominant decay symptom was blue mold followed by bull's-eye rot, gray mold, and moldy core rot. Fungicide treatment reduced the incidence of total decay in all experiments. The contrast in incidence of total decay between control and fungicide ranged from 2% to 5.8% after storage and 13.7% to 21.8% after shelf life, depending on the experiment. The fungicide reduced the incidence of blue mold, bull's-eye rot, and gray mold in two, three, and one of the four experiments after storage and four, three, and zero of the four experiments after shelf life, respectively. The fungicide reduced moldy core rot in the experiment with the highest incidence. The incidence of bitter rot varied from 0% to 4.4% depending on the experiment and was unaffected by the fungicide. However, the incidences of *Alternaria* rot, white rot, and *Rhizopus* rot were consistently low (≤1%) and unaffected by the fungicide. The results reinforce that orchard plot is a major source of variation in decay incidence and the development of decay symptoms during the shelf life is greater than during a long-term cold storage period.

Malus domestica Borkh., postharvest diseases, fungicide, fruit rot

PP92

Antifungal activity of natural extracts and essential oils against *Monilinia fructicola in vitro* and as ingredients of hydroxypropyl methylcellulose-based edible coatings for postharvest preservation of cold-stored 'Angeleno' plums

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The *in vitro* antifungal activity of different natural extracts and essential oils against *Monilinia fructicola*, the causal agent of brown rot of stone fruits, was evaluated as mycelial growth reduction on amended PDA plates. The most effective agents [cinnamon (CN), lemongrass (LG), geraniol (GE), and myrrh (MY)] were selected as antifungal ingredients of composite edible coatings (ECs) formulated with hydroxypropyl methylcellulose (HPMC) and beeswax. ECs were applied in *in vivo* curative experiments to plums artificially inoculated 24 h before with *M. fructicola* and incubated for up to 10 days at 20°C. The ECs formulated with 0.4% LG, 0.2% GE, and 0.5% MY were the most effective, with disease incidence reductions of up to 58% compared to the uncoated control. These ECs were selected and further evaluated to control brown rot and maintain postharvest quality of plums stored for up to 6 weeks at 1°C and 90% RH plus a shelf-life period of 4 days at 20°C. ECs formulated with GE and MY reduced brown rot incidence (percentage of infected fruit) by 45 and 70%, respectively, after 3 weeks, and brown rot severity (lesion size) by up to 50% after 6 weeks plus shelf life. Regarding fruit quality, all coated plums maintained higher firmness than uncoated control fruit and the 0.2% GE coating significantly reduced fruit weight loss after 6 weeks plus shelf life, without adversely affecting the fruit physicochemical (titratable acidity, soluble solids content, and volatiles content) and sensory (overall flavor, off-flavors, firmness, and external aspect) quality. Moreover, all coated plums showed higher gloss than uncoated fruit. Overall, the HPMC-0.2% GE coating could be an eco-friendly alternative to reduce decay and maintain postharvest quality of plums during cold storage and shelf life.

Brown rot, stone fruit, Prunus salicina Lindl., antifungal edible coatings, postharvest decay

Evaluation of the effectiveness of *Candida oleophila* against *Penicillium expansum* in postharvest storage

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Penicillium expansum is one of the main postharvest pathogens of apples. It attacks mainly as a secondary agent through accidental wounds caused during harvesting operations. To find new alternatives to chemical treatments, we evaluated the effectiveness of *Candida oleophila* (CO) against apple pathogens. Fruits were injured and inoculated with the pathogen at a concentration of 10^6 conidia/ml. The positive control was treated with pyrimethanil and the negative one with water. Treatment with CO and fungicide were done 24 h before and after the inoculation. The apples were stored in a cold room at 1.5°C and 90% R.H. for 60 days. Disease incidence was evaluated on apples every 7 days and three different categories were used (low, medium or severe infections). Results showed that disease symptoms on non-injured fruits were very low. After 35 days, we observed 1.67% disease incidence on CO treatment 24 h before inoculation and 4.67% on CO treatment 24 h later. After 56 days, we observed high disease symptoms both on untreated and CO treated fruits which were injured and inoculated. A 95% disease incidence was recorded on fruits injured and treated with CO before inoculation with *Penicillium expansum*. Pyrimentanil was effective in controlling disease but not at high level. Injured fruits sprayed with pyrimethanil and then inoculated showed 21.67% disease incidence, whereas it was 26.7% on fruits injured, inoculated, and then sprayed with pyrimethanil. Results showed that with a high *Penicillium expansum* inoculum, the efficacy of CO used in postharvest treatment is very low and cannot be used to effectively control blue mould of apple.

Candida oleophila, Penicillium expansum, apple, storage, postharvest

PP94

Efficacy of hydrogen peroxide + peracetic acid and trans-2-hexenal against apple rots during long-distance transport

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Preserving apples in semi-hermetic tray-packs is necessary when selling apples for long-term destination and allows to maintain a good intrinsic quality due to the good internal hygrometric conditions. However, long travel times (up to 45-60 days) and high humidity can induce the appearance of rots, moulds, and other secondary pathogens on the epicarp. With this experiment we aimed to verify the effectiveness of the bath treatment with a mix of hydrogen peroxide (25%) and peracetic acid (15%) and the gaseous treatment with trans-2-hexenal for the control of these fungi on 'Pinova' apples after storage into tray-pack. Apples treated with hydrogen peroxide + peracetic acid were left for 2 minutes in a water solution at a concentration of 1 ml/L and they were compared with apples in clean water. Aldehyde was applied on apples by evaporating the compound from a solution with a concentration of 12.5 µl/ml. All apples were stored in tray-packs at 1.5°C and 85% RH. Rot incidence was slightly lower on apples treated by hydrogen peroxide + peracetic acid after 30 days (-1% incidence) and 110 days (-2.6% incidence) of storage. On apples treated by aldehyde we did not observe any significant difference compared with untreated apples. Considering secondary pathogens, aldehyde treatment positively emerged after 30 days (-5% incidence), whereas during storage apples of all the treatments were infected by the pathogen. In conclusion, a certain level of effectiveness against apple pathogens could be observed, but further investigations are needed to better define dosages and application times.

Apple rots, moulds, aldehydes, peracetic acid, hydrogen peroxide, tray-pack, secondary pathogens

The biocontrol potential of the yeast *Candida oleophila* against *Penicillium expansum* in stored apples

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Penicillium expansum is one of the main postharvest pathogens of apples. It attacks mainly as a secondary agent through accidental wounds caused during harvesting operations. To find new alternatives to chemical treatments, we evaluated the effectiveness of *Candida oleophila* (CO) against apple pathogens. Fruits were injured and inoculated with the pathogen at a concentration of 10^6 conidia/ml. The positive control was treated with Pyrimethanil and the negative one with water. Treatment with CO and fungicide were done 24 h before and after the inoculation. The apples were stored in a cold room at 1.5°C and 90% R.H. for 60 days. Disease incidence was evaluated on apples every 7 days and three different categories were used (low, medium or severe infections). Results showed that disease symptoms on non-injured fruits were very low. After 35 days, we observed 1.67% disease incidence on CO treatment 24 h before inoculation and 4.67% on CO treatment 24 h later. After 56 days, we observed high disease symptoms both on untreated and CO treated fruits which were injured and inoculated. A 95% disease incidence was recorded on fruits injured and treated with CO before inoculation with *P. expansum*. Pyrimentanil was effective in controlling disease but not at high level. Injured fruits sprayed with Pyrimethanil and then inoculated showed 21.67% disease incidence, whereas it was 26.7% on fruits injured, inoculated, and then sprayed with Pyrimethanil. Results showed that with a high *P. expansum* inoculum, the efficacy of CO used in postharvest treatment is very low and cannot be used to effectively control blue mould of apple.

Candida oleophila, Penicillium expansum, apple, storage, postharvest

PP96

Early detect of botrytis rot in kiwifruit using hyperspectral imaging

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Botrytis rot in kiwifruit is a major postharvest disease. It is infected on the tree and develops when the temperature is raised to ripen after harvest. It is difficult to detect infection from the appearance of the fruit before ripening. If botrytis rot develops during the distribution stage, the product value will drop significantly due to disease symptoms such as odor and surface depression. It also infects other fruits, so early detection is required. Therefore, in this study, we investigated whether it is possible to detect early botrytis rot, which is difficult to visually identify, using a hyperspectral camera at an early stage and non-destructively. Forty-eight kiwifruit ('Hayward' variety, produced in Kanagawa Prefecture, Japan) in the early stage of ripening were used in the experiment. Ripening was performed at 20°C using a constant temperature chamber (IN804, Yamato Scientific), and during this period, a hyperspectral camera (SPECIM IQ, Spectra, 400-1000 nm, resolution: 7 nm, 512x512 pixel) was used once a day. Hyperspectral images of the fruit were obtained using two halogen lamps (150 W). Fourteen days after the start of the experiment, the skins of all the fruits were peeled and the presence or absence of botrytis rot infection symptom was visually confirmed. Symptoms of botrytis rot were observed in 11 fruits, and because only one side image was obtained, analysis was performed on 6 of these fruits. Using hyperspectral images previously taken, we retrospectively identified the parts of the infected fruit that showed symptoms of botrytis rot and the healthy parts. A region of interest with a diameter of approximately 1 cm was defined for each region using software (Spectronon, RESONON), and the average absorbance of the spectral data was determined. These were subjected to Savitzky-Golay differential processing and principal component analysis using software (The Umscrambler X, CAMO). As a result, principal component analysis revealed that the first principal component was the direction in which botrytis rot progressed, and the second principal component was the direction of the number of ripening days. Furthermore, when looking at the second derivative of absorbance, there was a characteristic difference between areas where disease symptoms appeared and healthy areas around 690 nm. From the above, we found the possibility of non-destructively detecting botrytis rot at an early stage using hyperspectral imaging.

Non-destructive measurement, postharvest disease, kiwifruit, botrytis rot, chemometrics

PP99

Untangling avocado stem-end rot: a metabolomic analysis of storage effects on 'Hass' avocados

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Stem-end rot (SER), caused by various fungal species in the Botryosphaeriaceae family, is one of the most notable postharvest diseases of avocados worldwide. This disease impacts avocado farmers economically, causing a loss of up to 30% of their marketable product. Despite its economic impact, there is limited understanding of how storage conditions influence the progression of SER, particularly given the quiescent nature of the pathogen. This study aims to bridge this knowledge gap by building a comprehensive metabolic panel of 'Hass' avocados under SER infection, focusing on the effects of different storage conditions on disease development. The dominant fungal species associated with SER in Southern California, *Neofusicoccum* spp. was selected for inoculation. 'Hass' avocados were inoculated at harvest or following 35 days of storage at 4°C using fungal plugs derived from 7-day-old cultures grown on potato dextrose agar. The fruits' firmness and dry matter content were measured before sample collection at the inoculation site. Samples were collected at 0-, 24-, 48-, and 96-hours post-inoculation. Processed samples were analyzed using untargeted Liquid Chromatography-Mass Spectrometry (LC-MS). Over 3,000 features were inspected, with confident identification of 260 metabolites through database searches, of which 207 exhibited statistically significant changes ($p < 0.05$) across the experiment. Notably, substantial changes in features associated with chemical groups like fatty acyls, fatty acids, glycerolipids, flavonoids, coumarins, and phenols were observed, with fluctuations in relative abundance starting at 48 hours post-inoculation and continuing through 96 hours. This data offers a snapshot of the metabolic variations occurring in avocado fruits as the pathogen progresses under storage conditions. This ongoing study sheds light on avocado metabolite changes during SER development across storage conditions, contributing to developing effective SER management strategies for the avocado industry.

Stem-end rot, avocado, metabolite, storage

PP100

Diversity of fungi on the epidermis of apples: exploring the microbiome with a cost-efficient user-friendly method

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This study investigates the fungal communities on the epidermis of apples obtained from German food retailers using a cost-effective and user-friendly method, which is based on cultivating fungal colonies on Sabouraud dextrose agar, followed by a combination of microscopy and DNA extraction with PCR targeted on internal transcribed spacers. The method was developed and validated to provide a reliable and efficient means of identifying fungal genera and species present on apple surfaces. Eleven different fungal genera were identified, with *Penicillium* spp. being the most prevalent. The study's findings indicate that certain fungi, such as *Trichoderma* spp. and *Aureobasidium* spp., have potential applications in biological control strategies against common postharvest pathogens. These fungi exhibit antagonistic properties that could reduce the reliance on chemical pesticides, thereby enhancing food safety and sustainability. This research underscores the importance of robust and accessible methodologies for studying fungal diversity, which can inform the development of sustainable postharvest treatment methods and contribute to improved management of postharvest pathology in apples.

Malus domestica Borkh., fungal identification, surface microbiota, affordable microbiome analysis, decay reduction

Molecular mapping of the FA7.0 locus responsible for high-content of folate in cauliflower

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With the human health industry emerging, nutritional quality of vegetables is increasingly considered to be an important marketing advantage. In the vegetable health industry, folate is becoming the hot spot, which plays an important role on human health. As folate is one of the vital nutritional ingredients in some types of cauliflower, high content of folate becomes to be a desirable trait in cauliflower germplasm screening and breeding. In this study, we analyzed the mapping of the folate synthesis regulatory locus by using an F_2 population constructed by crossing a high content of folate accession CF2301 with a low content of folate accession CF2302. All F_1 individuals had a middle content of folic acid, and the F_2 population showed a normal distribution of folic acid content, indicating that folic acid content is a quantitative trait which was controlled by a number of genes. To map the locus associated with folate synthesis, we performed bulked segregant DNA-seq (BSA-seq) analysis. The sequencing pools of high-content and low-content lines from the F_2 population were aligned to the high-quality 'Dempsey' reference genome to identify variants between the pools. The BSA analysis identified 105965 variants, and in chromosome 7 of CF2301, we identified the locus FA7.0 associated with the high folate content. To fine map FA7.0, Indel marker and Kompetitive allele-specific PCR (KASP) markers were developed based on variants obtained from the BSA-seq reads. Comparative analysis identified four CF2302-specific SNPs within the FA7.0 locus, and among of them, marker BoS0024 was closely associated with the phenotype. The result will contribute to the high-content of folate cauliflower breeding program.

Folate, cauliflower, molecular mapping, quantitative trait

Nutritional potential of cassava leaves as an underutilized component of the tuber crop

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Cassava (*Manihot esculenta*) is a significant staple food crop, with an annual global production of 330 Mt of fresh tubers (FAOSTAT, 2022). It is extensively cultivated in Africa and South-Eastern Asia. Although cassava is widely recognized for its tubers that are rich in starch, the leaves, which make up approximately 10% of the plant's total weight, are commonly discarded in the field during harvest, despite their high protein content. The reservations about eating cassava leaves are probably due to their content of cyanogenic glucosides, which can lead to serious health problems if prepared incorrectly. To harness the nutritional potential of cassava leaves, the composition in terms of protein content and composition, carotene, chlorophyll, and cyanide was analyzed in four cultivars grown in Thailand at different growth stages. The results showed a variation in the nutrient composition among different cultivars, positions within the plant, and ages of the plant. Strong correlations were observed between the levels of chlorophyll and carotenoids and the quantity of protein in cassava leaves. The highest nutrient content was found in the middle leaves harvested at 6 months after planting. Unfortunately, these leaves also exhibited high levels of total cyanide. This highlights the importance of using appropriate methods, such as pounding followed by boiling, to detoxify the leaves before consumption or utilization. Nevertheless, the findings of this study can help in selecting cassava leaves that can be used as a supplementary source of nutrients for human consumption.

Amino acids, carotene, chlorophyll, cyanogenic glycosides, protein, vegetable

Variation in yield, total chlorophyll, carotenoids and mineral content of field grown kale (*Brassica oleracea* Acephala group) varieties

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While kale is one of the oldest vegetables in the Brassica family, its cultivation hasn't always been very widespread. However, lately, it has gained "superfood" status, and its cultivation has become increasingly popular both in greenhouses and open fields. The aim of this study was to determine the yield of 15 kale varieties and the variability in the content of mineral elements, total chlorophyll and carotenoid content. The field trial was conducted in South Estonia in 2022. The kale varieties in the experiment were grouped into three different categories based on their appearance: a) green-leaved - 'Kadet', 'Halbhoher grüner kraused', 'Winterbor', 'Dwarf green curled afro', 'Tintoreto', 'KAL 1029 F1', 'Emerald Ice'; b) palm-tree type - 'Nero di Toscana', 'Cavolo Nero Raven', 'Cavolo Nero Black Magic'; and c) red-leaved varieties - 'Starmaker', 'Midnight Sun', 'Red Russian', 'KAL 1039 F1', 'Scarlet'. During the harvest, the height of the plants from the ground (cm) was measured, and the total yield and marketable yield were weighed. Following the harvest, the content of mineral elements (N, P, K, Ca, Mg, Zn, Fe, Mn, and Cu) in the leaves, dry matter content, chlorophyll a and b, total chlorophyll, and total carotenoids content were determined. The results of this study indicated a high variability among the examined kale varieties. The marketable yield of plants ranged from 465 to 2332 grams (average 1328 g), and the highest yield was obtained from varieties 'Winterbor', 'KAL 1029 F1', and 'Cavolo Nero Raven'. Dry matter content of leaves ranged from 14.7% to 21.5%, and the nitrogen content ranged from 3.21% to 5.77%. The content of total chlorophyll ranged from 86 to 451 mg/100 g, and total carotenoids between 10.6 and 36.2 mg/100 g. The variability of yield and biochemical content among the three variety groups will be discussed.

Plant height, chlorophyll a, chlorophyll b, dry matter content

Vitamin B9 content in strawberry genotypes and accessions from different European countries: the Breeding Value project

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The H2020 EU-Project Breeding Value (I.D. 101000747) involves many research groups, and public and private institutions from many European countries, with the general aim of providing the knowledge and tools to utilize strawberry, raspberry, and blueberry GenRes and pre-breeding material for the creation of new breeding possibilities. Among the specific objectives of the project, in Work Package 3 different phenotypic tools are applied to evaluate the plant resilience, fruit quality, and postharvest traits of different strawberry genotypes and accessions cultivated in many European countries. One of the target molecules to be evaluated is vitamin B9, also known as folic acid, which represent an essential compound in the human diet, given the big importance that covers in many metabolic process (e.g. the DNA synthesis and cellular proliferation). In this study, about 400 strawberry genotypes and accessions coming from 10 companies/institutions belonging to 7 European countries were evaluated through HPLC-FLD technique for the content of folic acid. The amount of this molecule resulted to be related to the genotypes, but also to the cultivation environment. The main outcomes of this study allow us to have a better picture of the potential variability of folic acid content in different strawberry genotypes in different environments, highlighting also which accessions or genotypes are more interesting from this point of view, and indicting which genetic material could be valorised and utilized for further breeding programs aimed at increasing vitamin B9 amount in strawberries.

Strawberry, horizon2020, folates, nutritional quality