

IHC2018-Symposium 32

Strategies and Technologies to Maintain Quality and Reduce Postharvest Losses

ORAL PRESENTATIONS

KEYNOTE 1

INNOVATIONS IN STORAGE TECHNOLOGIES

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Temperature and relative humidity control, sometimes supplemented with controlled atmosphere (CA) and modified atmosphere storage, are technologies that are used around the world to maintain quality of horticultural products. In the last decade or so, 1-methylcyclopropene (1-MCP) has been tested extensively for fruits and vegetables but the application is primarily limited to apples for a number of reasons including the challenges of ripening recovery of some treated products and cost-benefit ratios. Other approaches to 1-MCP application are being explored, but the success of 1-MCP has highlighted the need for different strategies for control of ethylene resulting in renewed interest in ethylene scrubbing technologies. Another new technology, known as dynamic controlled atmosphere (DCA), has also been developed and is sometimes used in conjunction with 1-MCP. DCA provides interesting comparisons with 1-MCP based technologies. Other technologies such as heat treatments, edible coatings and irradiation meet specific needs that can make them economically viable, although their application can be limited by consumer preferences. A whole range of potential technologies such as nitric oxide have also been extensively tested, along with other chemicals such as salicylic acid, polyamines, and γ -aminobutyric acid. While the study of these chemicals may lead to additional insights about ripening and senescence, the potential for commercial development remains less clear as factors such as patent control can be critical to their successful commercialization. In this overview, DCA, 1-MCP, and other selected technological innovations will be discussed in relation to factors associated with commercialization and their adoption by various industries.

SESSION I: Storage technologies and fruit storage

OS 1-1:

NEW TECHNOLOGIES TO MAINTAIN QUALITY AND REDUCE POSTHARVEST LOSSES OF TABLE GRAPES

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Delivering table grapes that are of exceptional quality and free of any defects or disease to different export markets is vital for table grape industries. After harvest, table grapes (climacteric fruit) do not improve, and maintenance of the quality achieved in the vineyard up to retail shelves remains a challenge. Currently, visual inspection before and during harvest in the vineyard, after harvest and before packaging in the pack house, is used to assess the risk of quality defects developing during the cold storage period prior to transportation to export markets. Table grapes are complex fruit that is prone to many different types of defects like berry crack,



Gray mold rot, SO₂ damage and browning. The berry browning phenomenon alone can manifest in 24 different phenotypes on white seedless grapes. Fourier transform near-infrared spectroscopy (FT-NIR) is an established method for measuring quality attributes of a wide range of fresh produce. Here we report the detection of two different browning phenotypes (chocolate browning and friction browning) during cold storage of Regal Seedless table grapes using FT-NIR spectra that were obtained in reflection mode of whole bunches. Visual inspection was used to score the browning defects of individual berries on bunches. The defects were then scored as 0=no defect and 1=defect present. Results obtained with orthogonal partial least squares discriminant analysis (OPLS-DA) of the bunch spectra showed that classification between healthy and affected bunches was possible. These results opened new possibilities in the development of quality checks for packed table grape bunches prior to export. This has a significant impact on the table grape industries. It will now be possible to evaluate bunches non-destructively during packaging to determine the possibility of these browning types present.

OS 1-2:

NEW GENETICS, NEW PHYSIOLOGY, NEW CHALLENGES FOR APPLE AND PEAR POSTHARVEST PERFORMANCE

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Significant gains in both textural quality and storage life of apples and pears have been achieved over the last 20-30 years. This success can be attributed to new cultivars with improved genetics for long-term storage, access to new technologies for extending storage life, and advances in handling systems used by suppliers and traders of fresh produce. Despite these successes, managing physiological disorders remains a challenge, with most cultivars having a genetic predisposition to some form of disorders. Breeding approaches often focus on enhancing features that positively influence consumer purchase behaviour (e.g. appearance, eating quality, size), whilst ensuring the predisposition to disorders is either low or manageable through pre- and post-harvest practises. Some disorders are more manageable than others; thus the extent by which breeding is used to reduce the predisposition varies by disorder. For flesh spot decay in pears, and internal browning in red-fleshed apples, breeding is critical to reduce the predisposition given the limited tools available for overcoming these problems in the orchard and coolstore. The methods used to screen for disorders also need to be considered. Sometimes fruit are exposed to supply chain conditions after commercialisation that weren't anticipated at the time of screening and unanticipated disorders can express. For example, an apple cultivar that showed no internal browning during shelf-life assessments at 20°C (conventional markets), had a drastic increase in incidence once temperatures exceeded 25°C (new markets with limited cool chain). The integration of postharvest research with breeding programme activity will help achieve a broader understanding of the metabolic processes involved in postharvest deterioration; currently the postharvest literature for apples and pears is dominated by a small number of cultivars representing a small fraction of the genetic pool.

OS 1-3:

POSTHARVEST AND STORAGE PRACTICES FOR OPTIMUM APPLE AND PEAR QUALITY IN CHINA

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In recent years, China apple and pear industry are still expanding. Apple and pear production reached 43.5 and 19.3 million tons respectively, accounting for 56.3 percent of the world and 76.3 percent respectively in marketing year 2017. Chinese apple and pear industry is sustaining above 30.0 million farmers and employees. This topic introduces China apple and pear industry, such as distribution and production of major apple and pear varieties, situation of harvest, sorting, packaging, storage, and trade for fresh pears, especially postharvest treatment and storage practices for optimum apple and pear quality in China. Present postharvest situation, main varieties capacity, distribution range of apple and pear refrigerated storage (RA), controlled atmosphere storage (CA), and natural cold resource storage (NA), such as in cellar or cave storage), 1-MCP in China were surveyed and analyzed respectively. The main problems of apple and pear storage and the postharvest technology trend in the future in China were discussed.

SESSION II: Alternative postharvest treatments for maintaining fruit quality

OS 2-1:

EFFECT OF LATE SEASON PHOSPHINE FUMIGATION ON DRIED FIG QUALITY

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Methyl bromide (MeBr) was the unique fumigant used to control storage pests in dried fruit trade. Due to its depleting effect on ozone layer, in 1997 parties agreed through the Montreal Protocol to phase out by January 1, 2005 in non-Article 5 countries and 20% reduction and final phase-out by January 1, 2015 in Article 5 countries (developing countries). MeBr is banned at world-wide level except controlled and critical uses. Turkey is the prime producer and exporter of dried figs and storage pests may create significant problems in trade. The research was carried to find out alternatives of methyl bromide in controlling major pests in dried fig trade. In addition to its effect on various stages of the target pests, effect of the treatment on the product quality plays an important role in its adoption. Dried fig fruit were exposed to magnesium phosphide (MgPH₃) for 5 and 7 days at two concentrations as 1.0 and 2.0 g phosphine per ton of dried fig under tarpaulin to control two major pests, fig moth (*Ephestia cautella* Walk.) and fig mite (*Carpoglyphus lactis* L.). The experiment was performed to determine the efficiency of phosphine treatment during the later part of the season, November to May, when the ambient temperatures are cooler than the initial part of the season. The control treatment was MeBr fumigation at 60 g/m³ concentration for 24 h. The results proved that the tested two MgPH₃ concentrations and exposure periods provided 100% mortality of the target species. After fumigation, fruit were stored further for three months under ambient conditions to assess impact on dried fruit quality. A minimum of 5 days exposure to PH₃ at concentrations of 1-2 g per ton of dried fig can be proposed as an effective fumigation alternative to MeBr during the later season.

OS 2-2:

REGULATION OF NITRIC OXIDE ON LIPOXYGENASE IN PEACH FRUIT DURING COLD STORAGE

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Nitric oxide (NO) has become a new messenger in plant biology with an important role in a plethora of physiological processes. The regulation of NO on the lipoxygenase (LOX) in 'Feicheng' peach fruit during cold storage was investigated. Peach fruits at physiological maturity were treated with 5, 15 and 30 µmol L⁻¹ NO solution, respectively. The activity of LOX in peach fruit was inhibited by NO during cold storage, especially 15 µmol L⁻¹ NO. The expression level of LOX family genes in peach fruit decreased at cold storage. The expression of LOX 1, LOX 2 and LOX 3 was first promoted and then inhibited over a week by NO, and the gene expression



of LOX 4 was inhibited and then promoted over two weeks by NO. The effect of 15 $\mu\text{mol L}^{-1}$ NO treatment was more obvious than that of 5 and 30 $\mu\text{mol L}^{-1}$ NO treatment. Isobaric tags for relative and absolute quantitation (iTRAQ) technology was used to analyze LOX protein in peach fruit. Comparison with control, the protein contents of LOX-1, LOX-3 and LOX-4 were down-regulated by NO during cold storage, while LOX-2 protein content was up-regulated. Density functional theory (DFT) B3LYP method was used to simulate the interaction between NO and LOX protein. The results showed that NO could bind to the active site of LOX protein via hydrogen bonding and tended to undergo glutathione reaction. It can be concluded that NO can control the activity of LOX by regulating the gene expression of LOX in peach fruit, and then affect the storage quality of peach fruit.

OS 2-3:

SUN EXPOSURE ALTERS APPLE PEEL TRITERPENE METABOLISM DURING AIR STORAGE

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Sun exposure is critical for red peel color development of many prolific apple cultivars. In warmer climates, high solar irradiance can lead to crop loss throughout the supply chain resulting from a variety of disorders. The metabolome was evaluated on the sun-facing and shade side of four apple cultivars during 6 months of cold air storage. Metabolic changes associated with sun exposure included the obvious differences of pigment levels and related pathways. Other differences not associated with appearance include sugars, sugar alcohols and organic acid levels. Our extended appraisal of the metabolome includes newly identified acyl esters of pentacyclic triterpene acids, alcohols, and diols were also impacted by sun exposure. For example, levels of triterpenol esters recovered in dewaxed peel are elevated in relatively shaded peel while esters of acyl esters of triterpene acids recovered in the wax fraction are elevated in relatively exposed peel. Possible roles and consequences of these changes will be discussed in the context of disorder development and appearance.

OS 2-4:

EFFECTS OF SULPHUR DIOXIDE AND CHLORINE DIOXIDE TREATMENTS ON QUALITY OF SULTANA SEEDLESS TABLE GRAPES IN STORAGE

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Sulphur dioxide fumigation is one of the most important factors that determine storability of table grapes. Despite its beneficial effects, there is a risk of having sulfite residues in grapes. In this study, the effects of sulfur dioxide pads and chlorine dioxide generators on storability of table grapes cv. Sultana Seedless packed in modified atmosphere were investigated. Grape samples were subjected to 4 different treatments as a) MAP (control group), b) MAP+ ClO₂, c) MAP+ SO₂ and d) Polyethylene (PE)+ SO₂ (commercial) after pre-cooling and packages sealed with plastic clips. Grapes in all treatments were stored at -0.5°C and 90% relative humidity for 3 months. SO₂ concentrations of grapes in MAP's and PE packages were determined as 0.53 and 8.30 ppm, respectively. Decay development increased significantly (26%) in ClO₂ treatment after 3 months of storage. Sensory evaluation scores also decreased due to increases in stem browning index and decrease crunchiness scores. ClO₂ treated grapes lost their marketability due to high decay development and loss of sensory properties after 3 months. Effects of different treatments on color, berry removal force, berry firmness and chemical



attributes of table grapes were similar. The results revealed that table grapes could be successfully stored for 2 months with ClO₂ generators and 3 months with SO₂ pads.

OS2-5:

EFFECT OF ULTRASOUND ON POSTHARVEST QUALITY AND STRESS MARKERS IN TOMATO FRUIT DURING STORAGE

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Tomato (*Lycopersicon esculentum*) is one of the most consumed fruit/vegetable whose consumption is associated with many health benefits. However, its highly perishable nature limits its postharvest life. Therefore, enhancement in the levels of plant protection as well as bioactive compounds by application of hormetic doses of abiotic stresses such as ultrasound (US) is gaining interest. Thus, the objective of this work was to determine the hormetic dose of US (Power 135 W, Frequency 42 KHz and treatment time 0-90 minutes at constant temperature of 16°C), and to identify the stress markers in early 72 hours of US application. Physiological responses (respiration, ethylene, H₂O₂ production, color change and weight loss); and primary metabolites, especially precursors of secondary metabolites were monitored as potential indicators of the stress responses. Physiological responses of the treated tomato were dose-dependent with minimal changes with US doses up to 30 min; but at dose of 45 mins, the rate of color change and weight loss were lowest, indicating hormetic response for tomato. Early responses, ethylene production and H₂O₂ accumulation in fruit tissue, were dose-dependent and reached peak levels 4 hours and 18 hours after US application, respectively. Amino-acids (AA) with high titer (>100 µg of ribitol equivalent/g of dried peel) were GABA, proline, and serine, increased up to the hormetic dose, but decreased beyond the hormetic dose. However, the titers of branched-chain AAs (valine, leucine, and isoleucine) in tomato, treated with hormetic US dose, were lower compared to those of the control, but they increased with higher US doses. Reduced titers of these AAs may indicate their utilization as carbon substrate during stress-induced altered metabolism and biosynthesis of volatiles. Reduced titers of oxalate, citrate, ketoglutarate and succinate may suggest fast-acting TCA cycle. Enhanced titer of phenylalanine indicates activation of shikimic acid-phenylpropanoid pathways. Results suggest that early events of ethylene and H₂O₂ production and changes in the levels of AAs could be used as stress markers to infer the intensity of the stress. However, hormetic dose of US has physiological significance from the standpoint of secondary metabolites in tomato and changes in the free AA profile in response to US can provide some insight into US-induced modifications in the secondary metabolites derived from those AAs.

OS 2-6:

EXOGENOUS NO IMPROVES THE METABOLISM OF MITOCHONDRIAL ENDOGENOUS NO OF PEACHES DURING COLD STORAGE

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Nitric oxide (NO) is an important signal molecule participating in various physiological processes of plant. Exogenous NO could regulate the content of endogenous NO and prolong the storage life of fruit. However, it is limited to understand the synthesis mechanism of endogenous NO in mitochondria of fruit treated with exogenous NO. In this experiment, Feicheng peaches were dipped with NO solutions and 2-(4-carboxyphenyl)-



4, 4, 5, 5-tetramethylimidazoline-1-oxyl-3-oxide (c-PTIO), as NO scavenger, to explore the effects of exogenous NO on the metabolism of endogenous NO in peaches during storage. The results showed that treatment with exogenous NO maintained relatively high contents of mitochondrial NO and S-nitrosothiols (RSNOs) of peaches during storage, increased the activities of mitochondrial nitrate reductase (NR) and nitric oxide synthetase (NOS)-like enzyme, and decreased the contents of mitochondrial L-arginine, nitrite, and nitrate. Contrary results were found in peaches treated with c-PTIO during storage. The results suggested that exogenous NO could improve the metabolic efficiency of mitochondrial endogenous NO by regulating the pathway of NOS-like enzyme, the reduction of nitrite and the content of mitochondrial RSNO of peaches during storage.

SESSION III: Logistics and processed produces

KEYNOTE 2

INTEGRATION OF GLOBAL LOGISTICS OF SWEET CHERRY, FRESH BLACK FIGS AND POMEGRANATES FROM TURKEY

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New developments concerning Consumer Driven Marketing strategy of sweet cherry, need different technical requirements, improvements, changes, in phases of growing, harvest, post-harvest applications, processing lines, storage, shipments, cool-chain, marketing, fruit presentation, shelf life duration and consumer satisfaction. During all phases of process there are technical procedures to follow. Each ring of the chain, technological applications has to be strong and joined in synchrony to compliment and support the whole process to maintain quality. Maintaining quality to consumer satisfaction starts with choosing right variety of cherry, which is compatible with right rootstock and growing at desired climatic condition, with suitable soil requirements. Depending on the distance of cherry buyers from the cherry growing area and different size and form of consumer packaging, new technologies and applications had and have to be innovated, to fulfill consumer demands. Design of cherry fruit quality maintenance has to be driven according to consumer demand and consumer satisfaction. I have been learning and applying my knowledge to fresh cherry industry, for the last 35 years. Will share my experiences with you. Still face problems even with all the new technologies trying to be implemented. As market and consumer demand and requirements are changing and standards improving, differentiating we will have to invent and apply new technologies to reduce postharvest losses and maintain quality of sweet cherries.

OS 3-1:

VIABILITY OF CHLORINE-INJURED INDICATOR AND PATHOGENIC COLIFORM BACTERIA ON FRESH-CUT CABBAGE STORED IN HIGH CO₂ ATMOSPHERES

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Electrolyzed water containing chlorine can induce coliform bacteria to be in a sublethal, injured state. Sublethally injured coliform bacteria on shredded cabbage was evaluated during storage in air or high CO₂ controlled atmospheres (CA) of 5%, 10%, and 15% and in a modified atmosphere packaging (MAP) using two types of packaging (an equilibrium of 5% CO₂/15% O₂ and 15% CO₂/5% O₂) at 5°C and 10°C, using the thin agar layer (TAL) method. Rinsing of shredded cabbage with electrolyzed water containing 25 ppm available chlorine reduced the indicator coliform counts by 0.4-1.1 log and caused sublethal injury at a 42-77% level. When shredded cabbage, nonrinsed or rinsed with electrolyzed water, was stored in a CA and MAP, coliform counts on TAL plates increased 2-3.5 log and 3.5-4.5 log from the initial counts during storage at 5°C and 10°C,



respectively, with the increase being greater in low CO₂ atmospheres. The extent of injury ranging from 24-95% for the coliform bacteria were detected on samples nonrinsed and rinsed with electrolyzed water during storage irrespective of the CO₂ atmosphere and temperature. Shredded cabbage was inoculated with chlorine-injured *E. coli* O157:H7 (%injury = 45-65%) by mixture with electrolyzed water containing 1 ppm available chlorine, and then stored in a CA and MAP. Counts of *E. coli* O157:H7 on TAL plates increased 0.5-1.4 log from the initial counts during storage at 10°C, with the increase being greater in high CO₂ atmospheres. Chlorine-injured *E. coli* O157:H7 (%injury = 34-74%) were detected on samples during storage irrespective of the CO₂ atmosphere and temperature. These results indicated that chlorine-injured indicator and pathogenic bacteria on fresh-cut cabbage were capable of exhibiting different degrees of injury during storage regardless of the storage atmosphere and temperature.

OS 3-2:

EVALUATION OF FRESH CUT ARILS QUALITY ATTRIBUTES PROCESSED FROM COLD STORED TUNISIAN POMEGRANATE FRUIT

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The cultivation of pomegranate is very old in Tunisia. Pomegranate is grown in the northern, central and southern coastal areas. This specie is considered a major component of the southern oases. However, there is a domination of varieties in 'Beja' and 'Nabeul' in the North, as well as 'Sidi Bouzid', 'Kairouan' and 'Mehdia' in the Center, and 'Gabès' in the South. However, the latter takes over most of the orchard. The objective of the present work is to assess quality of fresh cut arils over storage period of whole fruit. Fresh arils obtained from 'Gabsi' fruit stored at 2 °C for 0, 30 and 60 days were hand extracted, chlorine disinfected, rinsed, dried and then filled in PET trays and wrapped in PET film in 2 initial conditions: MAP1 (passive modified atmosphere packaging) and MAP2 (high CO₂), versus a control stored in air; all packed arils had 200 g of three replicates each. Physical quality evaluation was assessed on days 0 and 10 post cutting shelf-life from fruit stored for up to 60 days. Color (L* and a* values, Hue angle and Chromaticity) antioxidants (total phenols, anthocyanins) and antioxidant capacity were assessed. Arils packed either with MAP1 or MAP 2 maintained its physical quality (L*, a*, C*, h°) over storage time. However; pomegranate storage time influence significantly arils color attributes during post-cutting shelf-life. Phenols and anthocyanins decreased over storage time and the effect of MAP was relevant to maintain it comparing to control. Antioxidant activity of packed arils was maintained throughout storage time. For acceptable quality attributes of ready to eat arils a storage conditions with MAP at 4°C processed from cold stored fruit and a post-cutting shelf life of 10 days were achieved.

OS 3-3:

A RESEARCH ON THE FREEZING CONSERVATION OF SARILOP FIGS

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This trial was initiated in the harvest season of 2016, to determine the effects of freezing and thawing temperatures on fruit quality properties of hard-ripe and ripe maturity stages of Sarılop fig fruit during the postharvest period. For this purpose, after pre-cooling treatment, fresh fig samples, which were grown without any inputs, were frozen at -20 °C for 24 h and -40 °C for 8-10 h. Frozen figs were stored at -18 °C and 70-80% relative humidity with doypack bags for 10 months. After 60 and 300 days at -18 °C, fruit samples were thawed in plastic containers during 24 hours, at 0 °C and 4 °C, respectively. Specifically, the drip loss (%), firmness (N),



total soluble solids (%) and skin color (L) values were determined. Under tested freezing and thawing conditions, there was no statistically significant differences in the drip loss values, even if the lowest drip loss was found for freezing at -20°C for 24 h. Besides, fruit firmness decreased during the storage period both in hard-ripe and ripe fruit, and maximum total soluble solids were measured in fruit that was frozen at -20°C and then stored at -18°C for 300 days.

SESSION IV: Alternative Treatments

OS 4-1:

EXPLORING X-RAY TREATMENTS FOR DISINFESTING APPLES

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Access to international markets is becoming increasingly challenging. The New Zealand pipfruit export industry relies on effective and accepted methods of disinfestation to maintain market access. High pressure washing during packing removes many surface pests, and development of rotary washers has significantly improved removal of more challenging pests. However, additional control would be beneficial, particularly for removal of apple leaf curling midge (ALCM). In addition, codling moth (CM), being an internal pest affecting access to the Japanese market, is challenging to control. X-ray generating technologies are currently recognised as disinfestation treatments, with accepted standards outlined by the International Plant Protection Convention (IPPC). There are currently commercial x-ray facilities in different countries; numbers of facilities and volumes are expected to continue to increase for the foreseeable future. We discuss our examination of the effect of a range of x-ray treatments on five New Zealand apple cultivars to determine the tolerances of the fruit to x-ray treatments likely to control the two key pests, ALCM and CM. The effect of storage time before treatment was also examined and found to be an important factor in terms of fruit tolerance for the cultivar examined – ‘Royal Gala’.

OS 4-2:

EFFECTS OF CITRIC ACID AND ETHYLENEDIAMINETETRAACETIC ACID TREATMENTS ON BROWN MUSHROOM (*AGARICUS BRUNNESCENS*) STORED IN DIFFERENT TEMPERATURES

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Researches on postharvest storage of mushrooms have gained importance due to their short storage life. Brown mushroom (*A. brunnescens*) has an important share in mushroom production. This study was conducted to determine the effects of citric acid and EDTA treatments on brown mushroom stored in different temperatures. Mushrooms were harvested from the 1st flush at commercial mushroom farm and treated with citric acid (40 g l⁻¹) and EDTA (40g l⁻¹) for 3 mins. Non-treated mushrooms were evaluated as control. Treated and untreated mushrooms were covered with stretch film by placing into the polystyrene foam plates. Packed mushrooms were stored at 0, 4 or 7°C at 90% relative humidity for 15 days. With the extension of the storage period weight loss was found higher in 7°C than 0°C. The color of the mushroom treated with EDTA became partially darker, thus,



L* value was lower compared to the other treatments. These values showed declining trend during storage period and effects of application and storage temperature were found limited and unstable. Firmness of EDTA treated mushrooms were measured lower than the other treatments after 12 and 15 days of storage. Besides the negative effects of EDTA on color, wrinkling resulted in sensory scores below the marketable limits after 12 days storage. Untreated mushrooms had the highest scores even after 15 days of storage at 0°C and 4°C appearance scores were respectively excellent (5), good (4). The results showed that untreated Brown mushrooms stored at 0°C and 4°C and the ones treated with citric acid could be successfully stored for 15 and 12 days respectively.

OS 4-3:

RESPONSE OF POSTHARVEST QUALITY ATTRIBUTES AND TOMATO CULTIVARS TO GREENHOUSE MICROCLIMATE AND STORAGE CONDITIONS

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The postharvest quality management of tomatoes is important to limit the amount of losses that occur due to deterioration between harvest and consumption. This study was undertaken to investigate the effects of pre- and postharvest integrated agro-technologies, involving greenhouse microclimate and postharvest storage conditions, on the postharvest quality attributes of four tomato cultivars. Tomato fruit firmness, colour (hue angle (h°) and L* value), pH and total soluble solids (TSS) for the cultivars Bona, Star 9037, Star 9009 and Zeal, grown in a fan-pad evaporatively-cooled (FPVT) and an open-ended naturally-ventilated tunnel (NVT), were harvested at the mature-green stage. The tomatoes were stored for 28 days under cold storage conditions, with a temperature of 13°C and RH of 85%, and under ambient air conditions, with a temperature of $23 \pm 2^\circ\text{C}$ and RH of $52 \pm 4\%$. Sampling was done every seven days, starting on day zero. Statistical analysis was done using the MSTATC statistical package to perform ANOVA, and the Duncan's Multiple Range Test was used to separate the means. The greenhouse microclimates and the postharvest storage conditions significantly ($P \leq 0.05$) influenced the firmness, colour, TSS content and pH values of the four tomato cultivars. The NVT-grown tomatoes had a higher (by 7.4%) firmness which was retained for a longer period, while having an overall 10.3% higher TSS content for the 28 days of storage for all the cultivars, but lower L* and h° values, compared to the FPVT-grown tomatoes. Among the four tomato cultivars, Bona had the least firmness, which was found to be 21.5% lower than the firmest cultivar, Star 9009. It also had the highest TSS content (up to 8.3% higher) and the lowest pH, with 3.64, up to 5.0% lower than the other cultivars. Furthermore, Bona tomatoes had the lowest L* (by up to 17.5%) and hue angle (by up to 20.9%), and thus, ripened and deteriorated faster than the other three cultivars. Under ambient air storage conditions, the tomatoes had 13.6% lower firmness, 6.4% and 8.8% lower L* and hue angle, respectively, 17.7% higher TSS and 18.8% lower pH than the tomatoes in cold storage. This signalled rapid ripening and loss of acceptable quality. The interaction effects showed that cold storage conditions maintained the firmness of Bona tomatoes by 24.1%, whereas the firmness of the other cultivars were not significantly ($P > 0.05$) influenced by the storage condition treatments. FPVT-grown tomatoes had higher L* (by 10.4%) and h° (by 12.7%), when stored under ambient air storage conditions, compared to NVT-grown tomatoes stored under the same conditions. The three-way interaction effect of microclimate and cultivar with storage conditions led to 14.9% and 22.7% higher firmness, respectively, for Bona and Zeal tomatoes grown in the NVT, and stored under cold storage conditions, than those under ambient air conditions. Further, under cold storage conditions, FPVT-grown Bona was 33.9% firmer than FPVT-grown Bona stored under ambient air conditions. Similarly, the TSS content for the NVT-grown tomatoes was 20.0 to 26.2% higher under ambient conditions than cold storage conditions, for all the cultivars. The changes in colour of FPVT-grown Bona and NVT-grown Zeal were slowed down under cold storage conditions. Star 9009 and Star 9037 were the least affected by the interaction effects, retaining higher firmness with the least colour changes, although they had lower TSS and higher pH values.



OS 4-5:

EFFECTS OF MODIFIED ATMOSPHERE PACKAGING ON THE STORAGE AND SHELF LIFE OF POMEGRANATE FRUITS CV. 'HICAZNAR'

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The objective of this study was to determine effects of modified atmosphere packaging (MAP) on storage and shelf life of 'Hicaznar' pomegranate fruits. Pomegranate fruits were packaged with 5 kg- or 12 kg-bags of two different MAP materials (X-5, X-12, L-5 and L-12) and then kept at 6°C for 6 months and for 7 days at 20 °C. Unpackaged fruit stored in plastic boxes were served as control. X-5 and X-12 MAP bags reduced weight loss by 5 to 6 fold and L-5 and L-12 MAP bags only 2 to 3 fold during storage and shelf life, compared to control treatment. Higher weight loss in unpackaged fruits resulted in higher total soluble solid content than fruits packaged with MAP bags during shelf life period following cold storage. MAP bags significantly reduced loss of titratable acidity and ascorbic acid content and maintained visual appearance, retarded husk discoloration of the fruits after 6 months of storage at 6°C plus 7 days at 20°C. After both storage and shelf life periods, aril color of fruits packaged with X5 and X-12 MAP bags were less intense reddish (lower C*) with a lower antioxidant activity, total monomeric anthocyanin and total phenolic content in comparison to those from control and other MAP bags. X-5 and X-12 MAP bags reduced husk scald by 77-80% while L-5 and L-12 MAP bags only 37-44%, compared to control treatment. Incidence of fungal decay was lower in fruits packaged with MAP bags than unpackaged fruits. Unpackaged fruits remained marketable for only 4 months at 6°C plus 7 days at 20°C while MAP bags extended storage and shelf life to 6 months at 6°C plus 7 days at 20°C.

OS 4-6:

REDUCING PRE-HARVEST AND POSTHARVEST LOSSES IN SPINACH THROUGH THE IMPLEMENTATION OF HIGH TUNNELS

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The demand for locally grown fresh produce has been increasing rapidly in the U.S. To meet that demand, many growers are utilizing high tunnels, which have been successful in increasing the yield of several crops. However, little is known about the effect of this production system on the quality and shelf-life of fresh produce. Our objective was to determine how the high tunnel production system affects the pre-harvest and postharvest losses, of spinach, *Spinacia oleracea*, cv. "Corvair" in comparison with the open-field. The experiments were carried out at the Kansas State University Olathe Horticulture Research and Extension Center from 2014 to 2017. We utilized a split-plot randomized complete block design with six replications and typical production practices for the area. Mature spinach leaves were harvested and stored at 3°C and 13°C for 19 and 9 days respectively. The pre-harvest losses were evaluated in terms of yield, marketable yield and % marketability. To determine postharvest losses we evaluated respiration rate, overall quality, texture, color and nutritional quality during storage. In the growing season of 2015-2016, high tunnel spinach production significantly increased yield (82%) and % marketability (51%) when compared to open field. For both storage temperatures, spinach grown in the high tunnel maintained higher overall quality at the end of storage. Spinach grown in open-field demonstrated significantly higher antioxidant capacity (ORAC & FRAP) compared to high tunnel, throughout the shelf-life. There were no differences in total phenolic content and vitamin C between the two growing systems. Our results indicate that using high tunnels for local production of fresh produce could reduce pre-harvest losses by protecting the crop during production and help growers obtain high quality crops with longer shelf-life.



OS 4-7:

POST BLOOM SPRAYING APPLE TREES WITH PROHEXADIONE-CALCIUM AND GIBBERELIC ACID AFFECTS VEGETATIVE GROWTH, FRUIT MINERAL CONTENT AND BITTER PIT INCIDENCE

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Post bloom spraying apple orchards with prohexadione-calcium (ProCa, an inhibitor of gibberellins synthesis) can reduce vegetative growth and therefore increase calcium (Ca) uptake in the fruit. On the other hand, post bloom spraying with gibberellins (GAs) is used commercially to promote parthenocarpic fruit set and fruit growth, but it can increase vegetative growth and reduce fruit Ca content. Bitter pit (BP) is a physiological disorder caused by Ca deficiency in apples, also associated with increased activity of GAs in the plant. This study was carried out to assess the effects of post bloom orchard spraying with ProCa and gibberellic acid (GA₃) on vegetative growth, fruit mineral content and BP incidence. The experiment was carried out in southern Brazil. 'Catarina' and 'Fuji' apple trees were sprayed with water (control), ProCa (319 mg a.i. L⁻¹) or GA₃ (319 mg a.i. L⁻¹) at the petal fall stage (when shoots were 5-10 cm long), with reapplication 20 days later. During the trial, plants were not sprayed with calcium chloride to encourage the occurrence of BP. In both cultivars, yield and average fruit weight at harvest were not different among treatments, while vegetative growth (length of current season shoots) was reduced by ProCa and increased by GA₃ in comparison to the control. In fruit of both cultivars harvested at the commercial maturity and then left in cold storage (0±0.5°C/90-95% RH) for four months, followed by five days of shelf life, ProCa reduced while GA₃ increased the incidence (%) of BP in comparison to the control. In both cultivars, fruit from trees treated with ProCa had higher Ca content and lower (K+Mg+N)/Ca ratio in the peel tissue at the distal end than those from trees treated with GA₃. The results showed that post bloom spraying with GA₃ increases the risk of BP. The inhibition of GAs synthesis by post bloom spraying with ProCa reduced vegetative growth, improved fruit Ca accumulation and reduced the risk of BP.

OS 4-8:

AMBIENT LOADING - INCREASING CITRUS COLD CHAIN EFFICIENCY

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South Africa (SA) is an important producer and exporter of fresh citrus fruit, which is shipped widely and over large distances across the world. Future projections indicate citrus production will increase significantly, resulting in increased strain on precooling facilities. Additionally, international phytosanitary requirements are expected to become progressively more stringent, further increasing the demand for pre/cooling facilities. Ambient loading is a cold chain approach, whereby fruit by-pass a precooling facility and are loaded warm into the reefer container. This approach is a promising solution towards reducing strain on facilities, costs and dwell-times. The aim of this study was to examine the feasibility of applying ambient loading, by examining the resulting temperature characteristics in a reefer container during shipping, as well as the resulting quality preservation. The study also investigated the effect of packaging designs and modifications to the reefer container for improved cooling performance during ambient loading. Overall, ambient loaded fruit showed no significant difference in quality preservation when compared to the standard precooling approach. With respect



to a specified cold regime i.e. -0.6 °C or 2 °C, both standard ambient loading and ambient loading using a modified container required between 3-7 days to reach set-point. An unacceptable cooling uniformity was observed for the lower temperature (-0.6 °C) and the proposed container modifications were ineffective. However, product cooling rates to 2 °C were adequate and no quality loss was observed. Future prospects towards increasing cooling performance during ambient loading may lie in improving the design of packaging systems i.e. integration of the carton and pallet so as to facilitate reduced airflow resistance and more uniform airflow distributions.

SESSION V: Regulation of ripening, physiological disorders and control methods

KEYNOTE 3:

REVISITING THE REGULATION OF FRUIT DEVELOPMENT AND RIPENING: ANYTHING BESIDES ETHYLENE?

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Although the plant hormone ethylene is regarded as major regulator of climacteric ripening, the assumption that fleshy fruit ripening is driven by a complex hormonal balance in combination with the intervention of developmental factors like RIN and NOR has long been formulated, even though the mechanisms underlying this hormonal interplay remained elusive. Our recent work revealed that auxin signalling undergo dramatic decline at the onset of ripening in WT but not in tomato rin mutants impaired in ripening, suggesting that RIN might be involved in auxin decline. A SAUR gene regulated by RIN is involved in the regulation of auxin levels through the control of polar auxin transport. This SAUR gene showed positive responsiveness to auxin and ethylene and up or down -regulation of its expression in tomato resulted in premature or delayed ripening, respectively. These findings sustain the notion of a regulation loop, fed by ethylene and auxin as main hormonal signals, and by RIN and Sl-SAUR69 as modulators of the balance between the two hormones. The antagonistic interaction between auxin and ethylene is instrumental to the transition from autoinhibitory System1 to autocatalytic System2 of ethylene production, and therefore, the change from non-ripening to ripening of the genetic programming. Further evidence supporting the active role of auxin signalling in fruit ripening was also provided by the down-regulation of SlARF2, a member of Auxin Response Factor gene family in the tomato, which results in several ripening defects. ARF2 emerges as a new component of the regulatory network controlling tomato fruit ripening. While the link between ethylene- and RIN/NOR-dependent mechanisms during climacteric ripening is commonly accepted, so far, the precise role of Ethylene Response Factors (ERFs) in mediating ripening-associated processes remains unresolved. We recently showed that only a small subset of ERF genes display ripening-associated expression patterns. Further investigation suggested that a specific ERF sub-class might represent the missing link between the climacteric rise in respiration and autocatalytic ethylene production. Overall, the data support a model in which the regulatory network controlling fruit ripening relies on complex interactions between multi-hormonal signaling and developmental factors.

OS 5-1:

DYNAMIC CONTROLLED ATMOSPHERE STORAGE AND PHYSIOLOGICAL DISORDERS OF APPLE FRUIT

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Development of dynamic controlled atmosphere (DCA) storage technology for apple fruit has been partly driven by the need for a non-chemical replacement for the antioxidant, diphenylamine (DPA), as a means of controlling the physiological disorder superficial scald. In our experiments, we have found that control of superficial scald using DCA-chlorophyll fluorescence (CF) is similar to DPA or the ethylene perception inhibitor, 1-methylcyclopropene (1-MCP) for most cultivars. However, DCA-CF storage can also reduce the incidence of other physiological disorders. After 8 months of storage, 'Delicious' and 'McIntosh' had lower incidences of flesh browning and other disorders than those in CA storage. The lowest incidences of internal and external carbon dioxide injury occurred in DCA-CF-stored 'McIntosh', in part because DCA reduces the concentration of carbon dioxide required in the storage atmosphere to maintain flesh firmness. Incidence of a newly observed disorder of 'Gala' known as stem end flesh browning is also reduced by DCA-CF. The mechanisms by which low oxygen concentrations that are close to the anaerobic compensation of fruit inhibit development of physiological disorders will be discussed.

OS 5-2:

FACTORS AFFECTING INTERNAL BROWNING OF NEW APPLE CULTIVARS OVER LONG TERM STORAGE

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Longer term controlled atmosphere storage of new cultivars has led to observations of diffuse and radial flesh browning for these apples. Therefore, it was imperative to better understand factors that influence the incidence of this storage defect. Salish™ apple was used as the model cultivar for this research since it is currently commercially grown in British Columbia. Three commercial orchards were selected to bracket a range of cultural practices seen for this cultivar in British Columbia. Apples were harvested at four different maturities as determined using IAD values. They were stored in controlled atmosphere storage (1.5 kPa O₂ + 0.5 kPa CO₂) at 0.5 °C for four and seven months and then placed into 30 °C, 95% RH for two weeks before assessing internal browning incidence and severity. Internal browning was found to occur in two of the three orchards in the study. In the most susceptible orchard, there was internal browning for the apples harvested at the most advanced maturity at four and seven months. In the intermediately affected orchard, there was a low incidence at the most advanced harvest maturity but only after seven months of CA storage. The disorder was clearly associated with harvest maturity based on IAD harvest indices. In other experiments, it was determined that delayed cooling (holding at 10°C in air for 10 days before cooling and applying CA) and ultra-low O₂ (0.7 kPa O₂ + 0.5 kPa CO₂ at 0.5 °C) eliminated or significantly reduced incidence of internal browning at seven months, respectively. Internal browning can be managed by earlier harvests (based in IAD index values) and either delayed cooling or ultra-low O₂ CA storage. The orchard effect on susceptibility may be related to relative stress levels of an orchard.

OS 5-3:

EARLY DETECTION OF CHILLING INJURY INDUCTION IN EGGPLANT FRUITS DURING POSTHARVEST STORAGE

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Eggplant fruit is a chilling injury sensitive vegetable, thus should not be stored at lower than 12°C after harvest. However, often eggplants are placed in temperatures as low as 0-5°C, in order to prevent fast deterioration and decay, but this results in chilling injury symptoms development during distribution up to the loss of marketability. For this reason, a rapid early detection of chilling injury induction would be greatly acknowledged by the market agents, allowing rapid recovering of the fruit. Eggplant fruit (cv. Fantasy) were harvested from a commercial farm in (Lecce, Italy). Fruits were stored either at 2°C (chilling sensitive temperature) or at 12°C (safe storage temperature) for 10 days. Every 2 days, fruits from each group were sampled and left at room temperature, for one additional day, simulating one-day shelf life at the market. Before and after storage, as well as after shelf life, the color of each fruit was measured using a suitable colormeter, the reflectance spectra were acquired using a Fourier Transform (FT)-NIR spectrometer and hyperspectral images at the visible (400-1000nm) and near infrared (900-1700nm) part of the electromagnetic spectrum were captured using two hyperspectral cameras. Fruits were halved, and chilling injury development was subjectively evaluated according to the presence of black seeds or the extent of the discolored flesh area. PLS discriminant analysis were conducted for chilled and not chilled fruits, considering individual time of storage and shelf life, and the total dataset. Generally, both kind of spectra from FT-NIR and hyperspectral imaging system allowed a good classification of the chilled fruits. With FT-NIR spectra 100% of correct classification on external validation data set, was obtained already after 2 days plus one day of shelf-life. These results indicate a good potential of this technique to prevent postharvest losses due to incorrect temperature management of chilling sensitive fruit.

SESSION VI: Modified atmosphere packaging and quality retention

OS 6-1:

THE ART OF RESPIRATION MEASUREMENTS

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Respirations rates of fruit and vegetable samples are traditionally performed in cuvettes, or in comparable glass or plastic jars. Samples of air are taken from them with a syringe, through a septum, and analyzed by means of a gas chromatograph. The increasing CO₂ and decreasing O₂ partial pressures are determined over a known period of time. Taking samples from gastight jars has, however, a disadvantage: it creates an under pressure. Because septa are pierced several times, this under pressure can easily lead to leakage, and causing air to enter the jar. Air seeping in increases the O₂ partial pressure in the jar, causing noisier measurements, and an inaccurate analysis, because the uptake of O₂ seems lower than it is in actual. Respiration measurements are of increasing importance in postharvest laboratories. The behavior of respiration rates and the Respiration Quotient (RQ) of fresh produce, for instance, gives detailed insight in how fruits and vegetables adapt to changing gas atmospheres. The latest Dynamic Controlled Atmosphere (DCA) technologies, adjust the O₂ set point based upon the Respiration Quotient (RQ). Advanced Control of Respiration (ACR) of Van Amerongen CA Technology is an example of this RQ technology used in commercial operations. Furthermore, (changing) respiration rates feed models that form the base of Modified Atmosphere Packaging (MAP) technologies. The Respiration Analyzer that Food Technology Innovation (Fotein) has developed, consists of a (standard) 10 L, gastight container with a screw lid. Both the O₂ and CO₂ probes are mounted on the inside of the lid. Therefore, no samples have to be taken from the container, and the analyzers can determine respiration rates without creating an under pressure, which greatly improves accuracy. During an automatic 'run' of typically 1-4 hours, a software program monitors O₂ and CO₂. The duration of a run can be set, the same for the number of O₂ and CO₂ data points (generally 5-10). After all data points have been determined, the program draws trendlines through them, and calculates R-squares. Based on the trendlines, the program calculates the respiration rate, and the RQ. A probe will monitor temperature during each run. All data can be exported to Excel for further processing. The measurements can be followed and controlled remotely. The container has connections to manually, or automatically (with a conditioning unit), change the gas atmosphere inside the container, and investigate respiration parameters under different combinations of O₂ and CO₂. Obviously, the effect of temperature can be investigated by placing the container



in a cold store or fridge. The first respiration rate experiments with the software were done with kiwi and apple. R-squares were typically between 0.997 and 1.000. Data show a clear relation between O₂ partial pressure and respiration rate.

OS 6-2:

EFFECTS OF MODIFIED ATMOSPHERE PACKAGING (MAP) AND ALOE VERA TREATMENTS ON QUALITY CHARACTERISTICS OF CORNELIAN CHERRY FRUITS DURING COLD STORAGE

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This study was carried out to determine the effects of MAP and Aloe vera treatments on quality characteristics of cornelian cherry (*Cornus mas* L.) during cold storage. About 5 kg fruit for each treatment were harvested randomly. 150 fruits were used to determine quality characteristics at harvest. For cold storage, treatments were designed as control, MAP and Aloe vera. The fruits were stored in plastic boxes each of which contains 225 fruits. For each repetition 3 boxes were used. Fruits were stored in the same storage together, at $0 \pm 0.5^\circ \text{C}$ and $90 \pm 5\%$ RH for 7, 14 and 21 days and analyzed at the end of each storage period. In the study MAP and Aloe vera treatments significantly retarded weight loss throughout cold storage. In MAP and Aloe vera treatments, higher L*, and hue angle values were measured, while chroma values were lower. As compared to control treatment, higher flesh firmness values were observed in MAP and Aloe vera treatments at the end of storage. At the end of the storage analyses higher soluble solid content, titratable acidity and vitamin C values were obtained from MAP and Aloe vera treatments.

OS 6-3:

SHELF LIFE OF CAULIFLOWER IN DIFFERENT PACKAGES STORED AT TWO STORAGE CONDITIONS

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In Norway today, cauliflower (*Brassica oleracea*) is not packaged before distribution and sales in grocery stores. Unpackaged cauliflower heads are prone to weight loss giving rubbery texture, loose florets and yellow and withered leaves. The aim of this work was to evaluate the performance of three different packaging materials for cauliflower with unpackaged product as control. Quality and shelf life was evaluated during 16 days of storage in darkness at 4°C (Cold storage) or 4 days in darkness at 4°C + 3 days in light at 20°C + 9 days in darkness at 4°C (Retail storage). The different packages were 1: biaxially oriented polypropylene (BOPP) flowpack film with 40 micro perforations (Micro perforated), 2: BOPP flowpack film with a row of 560 needle perforations per 10×10 cm in the middle ("Bread film") and polyethylene (PE) cling film (Cling film). The weight loss was 10% for unpackaged cauliflower and below 1% for the packaged products stored at cold conditions for 16 days. At retail storage conditions, weight loss was 19% for unpackaged cauliflowers, 2.6% for the "bread film" and below 1% for the micro perforated film and the cling film. Retail storage, including 3 days at room temperature, had the highest effect on development of black spots (fungi) on the cauliflower heads, whereas limited effect was found for the different packaging materials on black spot development. Packaged cauliflower had firmer heads and better leaf quality than unpackaged samples. Cauliflower may benefit from packaging in order to inhibit weight loss and quality degradation, but packaged products stored at room temperature have increased risk of black spot development. Cold display in the grocery shops will give the best quality and longest shelf life for both packaged and unpackaged cauliflower.



OS 6-4:

RESEARCH ON THE EFFECTS OF 1-METHYLCYCLOPROPENE AND MODIFIED ATMOSPHERE PACKAGING ON STORAGE OF NECTARINE FRUITS

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Nectarine fruits are gaining popularity among consumers in the domestic and foreign markets, however significant losses may occur during transportation, in storage or at retail stages. The study aimed to determine the effects of 1-Methylcyclopropene (1-MCP) and modified atmosphere packages (MAP) on major quality parameters of 'Extreme® Sunny' nectarine variety during storage. The experiment was designed to test the six following variables: a) MAP1, b) MAP1+1-MCP (open top bag), c) RipeLock™ (MAP2)+1-MCP (closed bag), d) MAP2 with Smartfresh ProTabs™, e) 1-MCP treatment without MAP and f) non-treated in MAP accepted as the control group. Fruit in all six treatments were stored for 8 weeks at 0°C and 90% relative humidity conditions. Sampling was done at 2 weeks intervals and samples were then kept for 2 days as shelf life (20°C and 70% RH). During storage, the weight loss significantly increased in applications without MAP, and some of the fruits lost their marketable value due to water loss after 4 weeks storage with 2 days shelf life conditions. At the end of storage, the average water loss of the fruits in MAP2 applications were 1.83%, whereas 2.77% in MAP1. Decay developed after 4 weeks of storage and decay rate was higher in control fruits than MAP or 1-MCP treatments. Combined treatments showed slight decreases in fruit flesh firmness during storage. The effects of MAP and 1-MCP on total soluble solids, titratable acidity, pH value, total phenolic content and antioxidant activity parameters were similar. The results show that nectarine fruits could be successfully stored with MAP and 1-MCP for 6 weeks+2 days at shelf life conditions. RipeLock™+1-MCP treatment in nectarine storage may be preferred due to its ease of application.

OS 6-5:

DESIGN OF PERFORATED PACKAGES TO PRESERVE FRESH PRODUCE CONSIDERING TEMPERATURE, GAS CONCENTRATIONS AND MOISTURE LOSS

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In order to properly preserve fresh produce such as fruits and vegetables, the packaging system must have a suitable configuration to reduce its metabolic processes, microbial activity and deterioration. For this, it is necessary to establish an equilibrium modified atmosphere packaging (EMAP) with favorable concentrations of O₂ and CO₂, relative humidity (RH) and storage temperatures that do not result in chilling injury. The EMAP system is established once a balance is reached between the product's metabolism and the gas transfer through the package. For this study, a mathematical model has been developed to estimate the change in gas levels in perforated packages by considering their configuration, the respiration and transpiration in the product, the storage conditions and by using the appropriate mass and heat differential balance equations. From the developed model, a design strategy based on the product information and the packaged information is proposed to configure the packaging system for a defined product to rapidly establish an EMAP with low O₂ and moderate CO₂ levels in the headspace to reduce the product's metabolic processes and inhibit the microbial growth (Bovi et al., 2006). Likewise, a high enough relative humidity (approximately 80-90%) to avoid excessive water evaporation and weight loss but minimizing the possibility of saturation inside the package to avoid moisture condensation that contributes to deterioration in the product (Castellanos et al., 2016). To validate the design strategy, two different products, banana and tomato fruits, were taken as example and packaging materials with



different permeation rates to O₂, CO₂ and water vapor such as polypropylene (PP), polylactic acid (PLA) and ethylene vinyl alcohol (EVOH) were used to establish a suitable packaging configuration for each product.

OS 6-5:

THE EFFECTS OF 1-METHYLCYCLOPROPENE AND DIFFERENT CO₂ APPLICATIONS ON QUALITY AND ASTRINGENCY REMOVING OF 'HACHIYA' PERSIMMON CULTIVAR DURING STORAGE

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In this research, the effects of 1-Methylcyclopropene (1-MCP) and different CO₂ applications on quality and astringency removing of 'Hachiya' persimmon cultivar during storage were carried out. For this purpose, 1-MCP at dose of 625 ppb were treated before cold storage and stored with untreated fruits for 30, 60 and 90 days respectively. CO₂ applications were materialized on both treated and untreated fruits at doses of 60%, 70%, 80% and 90% at 20°C-22°C for 24 hours after each storage period. Persimmon fruits were kept at 20°C-22°C for 3 days after CO₂ applications as shelf life. Some quality parameters such as fruit firmness, skin color development, soluble solids content, tannin changes, acidity and visual quality were assessed after each storage period with applications and shelf life. According to the results; 1-MCP was found effective on quality parameters and 70% dose of CO₂ can be useful for removing the astringency.

SESSION VII: Workshop on alternatives to control postharvest decay and losses

OS 7-1:

UNRAVELLING THE MICROBIOME OF APPLE AND THE DEVELOPMENT OF MICROBIAL CONSORTIA TO MANAGE POSTHARVEST PATHOGENS

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Accumulating evidence indicates that the composition of the microbiota inhabiting an organism (both endo- and epiphytically) can have a profound effect on host physiology and defense responses. The role of the microbiota in plant health and physiology, however, is poorly understood, and few studies have focused on temperate fruit trees. A global effort is underway to characterize the endophytic and epiphytic microbiome of apple fruit with the goal of developing a microbial consortium for the management of a wide range of postharvest diseases, and potentially physiological disorders. Spatial studies of the microbiota of apple peel, calyx-end, stem-end, and wounds tissues have revealed distinct compositional differences, as well as differences between organic and conventional management systems. Other studies have indicated a distinct genotype effect on defining the endophytic microbiota in apple shoots. These data suggest that apple pedigree influences the composition of the endophytic microbiota and that the host and microbiome have co-evolved to some extent, as suggested in the holobiont concept. The effect of postharvest processes, such as waxing and storage, on the apple fruit microbiome will be presented, as well as a global analysis of the apple fruit microbiome. The implications of greater knowledge of the apple microbiome on disease and cultural management strategies, cultivar breeding, and abiotic stress resistance, will be discussed.



OS 7-2:

PROBIOTIC MICROORGANISMS AS NOVEL BIOCONTROL AGENTS OF POSTHARVEST PATHOGENS

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Numerous microbial antagonists (yeasts and bacteria) of postharvest pathogens have been identified in both laboratory, semi-commercial, and commercial studies. Several of these antagonists reached advanced levels of development and commercialization. Early investigations of potential biocontrol agents adopted the same strategy used for finding biocontrol agents against foliar and soil-borne diseases where the isolation and screening program was designed to identify single potent antagonists. This approach, however, neglected the fact that the introduced antagonist was not the only "player" present on the harvested commodity. The successful wide-spread use of biocontrol products based on a single antagonist, however, remains limited. This is for several reasons, among which are the inconsistency, and variability in the efficacy of the product under commercial conditions, as well as the lack of understanding of how these antagonists interact with the existing natural microflora on intact and wounded fruit surfaces. In attempt to overcome the shortcomings of existing biocontrol strategies for managing postharvest pathogens, we have begun to investigate the microbiome of a variety of fermented foods in an attempt to identify probiotic, natural microbial consortia capable of exhibiting robust and consistent biocontrol efficacy against a wide range of postharvest pathogens. The composition of the microbiota of different dairy and vegetable-based fermented foods, will be presented and the potential use of synthetic microbial consortia for biocontrol will be discussed.

OS 7-3:

POSTHARVEST APPLICATION OF DISINFECTING AGENTS FOR CONTROLLING FRUIT AND VEGETABLE DISEASES

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During harvest, packaging, and storage operations, fruits and vegetables are exposed to various contaminations. A critical point during postharvest handling chain is washing, in which cross-contamination by specific pathogens may occur. Sanitation is of great importance to handlers, not only to protect commodities against postharvest diseases, but also consumers from foodborne pathogens. Use of proper sanitizers help preventing product contamination and maintaining the water free of pathogens. Various disinfectants are available, however, those most used, such as sodium hypochlorite, have limitations due to risks for environmental and human health. Among the alternatives to sodium hypochlorite, electrolyzed water (EW) has recently become a popular sanitizer in the food chain. EW was firstly developed in Russia for water decontamination and regeneration; then, it gained great interest in Japan and other countries, for sterilization of utensils, meats, cutting boards, and recently, in livestock management and for the sanitation of the washing waters of fresh and minimally processed fruits and vegetables. Generation of EW, effect of electrolytes, advantages and disadvantages on its application, physical parameters, mode of action and efficacy on different commodities will be reviewed. Particular emphasis is given to the application of EW in the washing process of fresh fruits and vegetables and its integration into current practices of postharvest handling.



SESSION VIII: Consumer's Behavior and Health Benefits Effects of Fruits

KEYNOTE 4:

FRUIT AND VEGETABLE CONSUMPTION: THE ROLE OF CONSUMER ATTITUDES, HABITS AND ROUTINES

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Fruit and vegetable (F&V) consumption is an increasing focus in the debate over both public health and food waste. Consumers are being told to buy and eat more F&V, and that they need to stop throwing it away (noting that 20% to 70% of wasted food is F&V). These two seemingly consistent messages can create a dilemma for consumers because their weekly food provisioning routines might well lead to both purchasing more and wasting more F&V. Evans (2011) argued that we should not blame individual consumers, but rather target improvements in the formats and the ways food is distributed. In this presentation, the smaller literature on F&V is incorporated into the more substantive food literature in order to understand how consumers manage F&V inventory in their homes and why they often fail to consume healthy foods. Assessment of the literature requires consideration of individual eating situations as defined by the people, the place and the product (Jaeger et al., 2011). The argument is made that through understanding consumer habits and routines as well as F&V quality in the home, the horticultural sector (both industry and science) may advance the development of strategies and technologies used to maintain quality and reduce postharvest losses from households. Furthermore, it is suggested that postharvest scientists need to develop closer collaborations with social scientists to enable extension of our knowledge of the distribution chain to the point of in-home consumption.

OS 8-1:

GROUP AGGREGATION CAN CONTRIBUTE TO POSTHARVEST LOSS REDUCTION AND BETTER MARKET ACCESS FOR SMALLHOLDER FARMERS: MANGO CASE STUDY

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Mango is one of the major fruits produced in Kenya mainly by smallholder farmers. Mango fruit production by the average smallholder farmers is approximately 6 to 9 tons or 20,000 to 30,000 fruits harvested cumulatively over the 4 months fruiting season (December to March). For individual farmers, this falls short of the volumes demanded by processors and traders. Without appropriate storage facilities for the highly perishable mango fruit, the farmers are reduced to price-takers by the middlemen who source the fruit on-farm from the individual farmers. The average on-farm price for one fresh mango fruit is 3-5 US Cents. This is more than 10 times lower than the average price (30 to 50 US cents) for the same fruit in retail outlets in cities. This scenario is further aggravated by high quantitative and qualitative losses reported on-farm. As a result, despite the high potential, mango farming/production is not profitable for the smallholder farmers. It is against this background that the concept of aggregation centers for smallholder horticultural farmers was conceived under the Yieldwise project of Rockefeller Foundation. Village/group aggregation centers is a strategy that entails pooling smallholders into commodity group with the aim of realizing better quality and quantity demanded by the market. The strategy includes training group members on good production, harvest and postharvest handling practices and supporting them to access better storage and agro-processing facilities. Under the Yieldwise project, University of Nairobi and its partners have rolled out a group aggregation center for the Karurumo Horticultural Self Help Group in Embu County, a major mango producing County in Eastern Kenya. The center has been equipped with precooling and cold storage facilities for fresh mango fruits and facilities for processing surplus fruit into shelf-



stable products. This paper examines the challenges faced by smallholder farmers in their bid to market the fruits as individuals. The benefits accrued from group aggregation including better quality, large volumes, opportunities for processing the surplus fruits into shelf-stable products will be discussed. Through aggregation, the smallholder farmers can attain required volumes and quality and negotiate better prices from traders. Processing of the surplus mango fruit not only diversifies the product range but also transforms the perishable fruits into shelf-stable products thereby extending their marketing period. The ultimate goal of this intervention is to demonstrate that aggregation centers can enable better market access while reducing postharvest losses and ultimately improve profits for the smallholder farmers.

OS 8-2:

SOLANACEOUS CROPS: A SUSTAINABLE SOURCE OF VALUABLE BIOACTIVE LEAF COMPOUNDS?

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Modern horticulture targets both sustainable food production and non-competitive use of biomass residues for the extraction of bioactive compounds potentially of high interest for both the health care and pharmaceutical sectors. Annually, huge amounts of green biomass accrue in sweet pepper and tomato cultivation. These materials contain many different secondary metabolites such as phenolics and isoprenoids. According to their healthy and medicinal properties these plant-based compounds are of high interest for the pharmaceutical, cosmetic and dietary sector. From the plant biochemical perspective, the accumulation of secondary metabolites is a measure of plants to cope with abiotic stress conditions. As well-known example, flavonoids accumulate in leaves due to extreme nutritional imbalances, strong or extended light exposure, drought or salt stress. Thus, though manipulation of the growing parameters, a targeted enrichment of specific bioactive leaf compounds is feasible. The determination of highly accumulated amounts and, therefore, of optimal harvest time points can be supported by optical measurement techniques, e.g. fluorescence and hyperspectral devices assessing physiological and biochemical alterations in the plant tissues. In the context of the BioSc project InducTomE (www.biosc.de/inductome) and the recently started BMBF-project TaReCa, we focused on the accumulation of flavonoids and isoprenoids during additional lighting and salt stress on sweet pepper and tomato. One aim is to monitor the accumulation of the bioactive compounds using fluorescence and spectral based non-destructive indices as well as standard HPLC analysis. Our first results in tomato show that the content of rutin was increased in young leaves under LED light and sodium vapour lamps, while the content of solanesol was significantly increased in mature leaves under salt stress cultivation. Metabolic alterations were also triggered in sweet pepper under different light and salt conditions. The changes of plant metabolism were well indicated by the index of epidermal flavonols (FLAV) under light impact and the blue-to-red-fluorescence ratio (BFRR_{UV}) under salt influence. To ensure the utilization of solanaceous biomass residues, further effective treatments will be identified for triggering the enrichment of bioactive compounds in commercial-like greenhouse production.

OS 8-3:

EFFECTS OF PRETREATMENT DURING DRYING ON THE ANTIOXIDANT PROPERTIES AND COLOR OF SELECTED TOMATO VARIETIES

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Tomato (*Lycopersicon esculentum* mill) is among the most highly consumed and popular vegetable in the world. Tomato production in Kenya has increased in the recent past with the adoption of greenhouses. However, being climacteric crops, tomatoes are inherently perishable with a shelf life of 8-12 days in their fresh state after harvest. This has led to extensive postharvest losses which is estimated to be as high as 50%. These losses translate to a subsequent imbalance in supply and demand and consequential losses in income to both small and large-scale farmers. In order to sustain surplus harvest, appropriate postharvest preservation methods are needed to extend the commodity's shelf life. One such technology is drying which lowers the moisture content and consequently the water activity of food to a level that does not support bacterial and mold growth. Thus, this study investigated the effect of pretreatment on the retention of the antioxidant properties and color of four tomato varieties; i.e. Anna F1, Kilele, Prostar F1 and Riogrande during drying. Prepared quarters were treated by spraying with 0.5% sodium metabisulphate, 0.5% calcium chloride and distilled water. The quarters were oven dried at 50 °C, 60 °C and 70 °C to 13% moisture content. Lycopene, β carotene, total phenolics, color, and moisture content were determined in both the fresh and dried samples. Initial moisture content among the four varieties did not differ significantly and ranged between 94.2-94.6%. Results showed that the main effects were significant ($p < 0.05$) on all measurable variables. Significantly ($p < 0.05$) higher retention levels in lycopene, β carotene, total phenolics and lightness was observed in chemically pretreated samples compared to the control during drying.

OS 8-4:

RECENT DEVELOPMENTS IN BABY FOOD PRODUCTION (FRUIT JUICE BUSINESS)

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Important steps in agricultural side for baby food, selection of the appropriate fruit varieties to be produced for the baby food product, selection of the correct plant area, application of biological methods and meeting the agricultural regulations and supply chain from fruit gardens to fruit factories. Critical process steps in the production of puree, puree concentrate and fruit juice concentrate with new technology; For baby food, puree and puree concentrate production began with partial disinfection of the fruits. Reduction of the color protective chemicals of the shell soot by cold extraction in an oxygen-free environment. Effect of the pasteurization temperature and turbo-pulper paddle on the product. The effect of turbo pulper sieve pore size on viscosity. Party forming method and aseptic filling packing. In the production of clear fruit juice, the process begins with partial disinfection of the fruit and continues with pressing and clarification after shredding. Reduction of auxiliaries used with new technology filtration process. Finally, quality control analyzes will be discussed in the production of puree and clear fruit juice for baby food.

SESSION IX: Controlling physiological disorders and extending shelf-life

OS 9-1:

CAN CHANGES IN CHLOROPHYLL FLUORESCENCE BE USED TO DETERMINE CHILLING INJURY OF COLD STORED FEIJOA?

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Chilling injury (CI) is a physiological disorder that occurs when tropical or sub-tropical plants are exposed to low but non-freezing temperatures. Feijoa is a subtropical fruit that has potential for increased export from New Zealand, but its storage life is limited by chilling injury, with some varieties such as 'Kakariki' being particularly



susceptible. Physiological indicators that show when plants are experiencing chilling injury before it has become irreversible would be extremely useful, as they would allow remedial steps (such as intermittent warming) to be taken. Chlorophyll fluorescence can be used as an indicator of stress in photosynthetic systems but much remains to be found before it can be used successfully to protect stored products from CI. The objective of this study was to determine if changes in chlorophyll fluorescence could be used to detect development of irreversible chilling injury of feijoa. In the first season of research, a 15 % reduction in maximum photochemical efficiency of photosystem II (Fv/Fm ratio) was found during prolonged storage at 2 °C or 4 °C and when fruit were rewarmed after prolonged cold storage the Fv/Fm declined further. Data from a second season will be presented in which we are testing whether intermittent warming to 20 °C for 24 hours after every 13 days can be used to protect the tissue from CI. In particular, we will assess whether Fv/Fm recovers if fruit are rewarmed before CI becomes irreversible; and whether some aspects of chlorophyll fluorescence could be used for non-destructive prediction of irreversible CI.

OS 9-2:

EFFECTS OF STORAGE TEMPERATURE AND HOT WATER TREATMENT DURATION ON CHILLING INJURY OF MANGO (*MANGIFERA INDICA* L.)

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Low temperature storage is the most effective method of extending postharvest life and marketing period and maintain fruit quality. Unfortunately, for chilling injury sensitive fruits such as mangoes, low temperature storage may be detrimental than beneficial due to chilling injury which reduces fruit quality and customer acceptance, compromise the marketing of stored fruits, limit processing industry storage of the fruit and supply and or availability over a long period. The effects of storage temperature and hot water at various temperatures and durations on alleviation of mango chilling injury were evaluated on Keitt mango fruit cultivar in Botswana. The treatments were mango fruits dipped in distilled water at room temperature (25 ± 2 °C- control), mango fruits dipped in hot water at 50 and 55 °C for a duration of 3, 5 and 10 minutes, and storage temperatures at 4, 7, 10, 13 or 25 ± 2 °C, plus 95% RH. Mango fruits dipped in hot water were cooled and then stored at temperatures indicated above. The results showed that storage temperature, hot water treatment and hot water treatment duration significantly ($P < 0.05$) influenced the mango chilling incidence development and severity. As storage temperature decreased below 13°C, the mango chilling injury incidence and severity significantly ($P < 0.05$) increased. As the water temperature increased from 25°C to either 50 or 55°C, and duration in which mango fruit were held in hot water increased from 3 to either 5 or 10 minutes increased, chilling injury incidence and severity significantly ($P < 0.05$) decreased. There was a significant ($P < 0.05$) effect of the storage temperature and water temperature interaction on mango proline content and electrolyte leakage immediately after cold storage and 7 days after cold storage on fruit held at room temperature. As the storage temperature and water temperature decreased, the proline content and electrolyte leakage increased significantly ($P < 0.05$). It was recommended that in order to reduce Keitt mango chilling injury incidence and severity the fruit should be treated with hot water at 55°C for 10 minutes and then stored at 7°C.

OS 9-3:

QUANTITATIVE PROTEOMIC ANALYSIS REVEALS PROTEIN CHANGES IN SOFT SCALD DISORDER DEVELOPMENT IN RESPONSE TO GENOTYPE VARIATION IN APPLES

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Apple fruit (*Malus domestica*) is one of the most consumed fruits in the world due to its flavor quality and nutritional value. During storage, apple can develop many kinds of physiological disorders. Among them, soft scald disorder, especially in 'Honeycrisp' apples could cause significant economic losses to the fruit industry. Research has indicated that development of soft scald is influenced by many pre- and postharvest factors. Despite the intensive research, the fundamental metabolism responsible for soft scald development in apples is not fully understood. In order to reveal the molecular mechanism of soft scald development, the effect of variation of genotypes of apples and proteomic changes of soft scald development was investigated for 2013 and 2014 seasons. Among the two seasons, 88 and 140 apple cultivars grown in Nova Scotia were evaluated. Fruit were harvested at commercial harvest maturity and stored at 1.0 °C for three months. Soft scald incidence and fruit quality were evaluated. A quantitative proteomic with stable isotope dimethylation labeling by peptides study was conducted to reveal the proteomic changes between selected cultivars with significant scald development against five non-scalded cultivars. In total, 375 and 228 common proteins were identified and quantified from all labeling studies of all cultivars for 2013 and 2014 respectively. Seventy six and 57 proteins were identified as significantly changed proteins with 2-fold or more in response to cultivars and in relationship to scald, for 2013 and 2014 respectively. The cluster analysis and protein function analysis revealed the quantitative changes in proteins in association with protein metabolism, photosynthesis, signaling, amino acid metabolism, cell wall, transport and stress were increased, while redox, hormone metabolism, DNA synthesis/repair, co-factor and vitamin metabolism and major sugar metabolism were decreased. Differences in protein abundance in response to cultivars were also revealed and discussed. This study demonstrates that cultivars play significant role in soft scald development in apples, which provides evidence on the potential molecular regulation on soft scald development and possible mechanisms.

OS 9-4:

BLUE LED SUPPLEMENTATION DURING GROWTH ALLEVIATES POSTHARVEST CHILLING INJURY IN TOMATO

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Susceptibility of tomato (*Solanum lycopersicum*) to chilling injury (CI) limits the possibility to apply low temperature storage to prolong the shelf-life and maintain quality. Blue light (BL) is reported to enhance the antioxidant activity in fruit that might be beneficial in alleviating CI. Here, the effect of BL on chilling sensitivity of tomato (*Solanum lycopersicum* 'Foundation') was evaluated. The experiment consisted of two factors. Three Red:Blue LED light ratios (100%:0%, 88%:12%, and 76%:24% with a total irradiance of 175±5 µmol m⁻² s⁻¹ during cultivation), and post-harvest chilling treatments (0, 10, and 20 days chilled at 4°C followed by 15 days of shelf life at 20°C) applied to mature green fruits. CI is quantified as lower synthesis of lycopene, accelerated fruit softening and weight loss during shelf-life. It was demonstrated that fruit grown in 12% BL had considerably higher firmness after 10 and 20 days of chilling and lower weight loss at the end of shelf life. Fruit grown in 0% and 24% BL, experienced excessive softening during 10 and 20 days chilling and developed more pitting at the end of shelf life compared to fruit grown at 12% BL. Although 12% BL clearly indicated increased resistance against CI, this was only partially reflected by increased MDA values, usually taken as indicator of membrane damage. For this experiment, weight loss seems to be the most accurate method to indicate membrane damage due to CI. Further biochemical and transcriptome analyses are underway to reveal the mechanisms that allows intermediate BL levels during cultivation to protect against CI. In conclusion, intermediate levels of BL during growth alleviates CI in tomato.



OS 9-5:

PLANT GROWTH REGULATORS AND FRUIT MATURITY AFFECTS FRUIT COLORATION ON UNBLUSHED SIDE OF AIR STORED 'FUJI' APPLES

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Fruit color is an important motivation for consumer preference. The phenolics, anthocyanins and flavonoids are responsible for skin coloration as well as health benefits associated with anti-tumor, antioxidant, and cholesterol-lowering properties. In this research we investigated whether a preharvest treatment with the plant growth regulators (PGRs) aminoethoxyvinylglycine (AVG, ReTain®) and 1-methylcyclopropane (1-MCP, Harvista™) could influence coloration in 'Fuji' apples harvested for two consecutive weeks, then untreated or treated with 1-MCP after harvest, and stored in air for 3 and 7 months. Hue angle, chroma (C*), IAD values, anthocyanin and flavonol concentrations in the skin tissues from the unblushed side of the fruit were measured. Overall, the most determinative factor for fruit coloration of air stored fruit was harvest date, followed by PGR treatment, and shelf life period. Postharvest 1-MCP treatments did not affect anthocyanin concentrations but increased the effects of ReTain® treatments on hue angle values, resulting in more greenish fruit. Harvista™ can be a promising treatment for fruit harvested early in the harvest window and stored in air at 0.5 °C due to its positive influence on C* values and anthocyanin content.

OS 9-6:

EXTENDING THE SHELF-LIFE OF VEGETABLES USING LOW COST EVAPORATIVE COOLING SYSTEMS IN MALI

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Vegetables are nutrient dense and important sources of micronutrients. However, postharvest losses in sub-Saharan African countries range from 20 to 80%. To reduce postharvest vegetables loss, there is a need for affordable and locally available technologies. The aims of this study were a) to compare the efficiency of different zero energy cooling chambers (ZECCs) at reducing temperature, maintaining humidity and prolonging shelf-life of stored vegetables, and b) to assess with farming communities in rural Mali, the efficacy and potential for adoption of different clay pot cooling systems. Different ZECC types (bricks, sacks and straw) as well as clay pots (pot-in-pot, cylinder-pot-in-dish and round-pot-in-dish) were constructed and installed. Temperature and humidity were monitored regularly. Different vegetables, were placed in ZECCs and pots in order to assess the effect on shelf-life. The control mimicked the traditional storage practice and similar vegetables were stored using baskets. The results indicated that the ZECC made from bricks significantly reduced temperature and increased humidity up to 85%. The straw and sack ZECCs held less water and thus needed the water replenishing more frequently than the brick ZECCs. As a result, the shelf life of the vegetables was longer in the brick ZECCs followed by the sack. Among the clay pots, the pot-in-pot system provided significantly reduced temperature and an increased humidity. The study of the clay pot cooling methods by farming communities suggested that the pot-in-pot methods provided the advantage of extending the vegetable shelf life by 3 to 7 days. Overall, these results indicated that ZECCs and clay pot evaporative cooling chambers can play significant role in poor, rural communities to improve incomes and income stability by reducing post-harvest losses through extending vegetable shelf-life. Hence, policy makers should promote and enable implementation of these simple technologies in major vegetable producing and small market locations.



SESSION X: Non-Destructive Quality Determination and Quality Control

OS 10-1:

NEAR INFRARED (NIR) SPECTROSCOPY APPLICATIONS FOR EXTERNAL AND INTERNAL QUALITY ANALYSIS OF SOUTH AFRICAN CITRUS FRUIT: WHAT WE KNOW AND FUTURE PROSPECTS

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Citrus fruit quality assessment is highly based on external appearance, which influences consumers' initial decision to purchase. The decision for subsequent purchases is governed by the certainty that the visual appearance of purchased fruit will be matched by a rewarding sensory experience at the time of consumption. Therefore, integrated quantification of external appearance, internal organoleptic and nutritional quality is vital. Under present fruit grading systems, fruit with slight external defects are graded and marketed with unblemished fruit, thereby reducing the quality of the batch. The challenge is high regarding progressive rind disorders that do not manifest during grading but develop 1-5 weeks after harvest; such as rind breakdown disorder and rind pitting. The challenge is therefore to develop non-destructive technology to determine rind quality on the packing line to assist in the sorting and segregation of fruit into pertinent quality grades. Our recent studies have shown that visible to near-infrared (Vis/NIR) spectroscopy (Vis/NIRS) is the most advanced and accurate in predicting the susceptibility of 'Nules Clementine' mandarins to rind breakdown, 'Marsh' grapefruit and 'Valencia' to rind pitting disorders. Our studies have also shown that non-visible information provided by the NIR region of the electromagnetic spectrum can improve grading by detecting fruit origin within the canopy and allowing the detection of biochemical differences between individual fruits in a batch, thus, estimating the internal organoleptic quality parameters and susceptibility to rind physiological disorders. The important objective governing this Vis/NIRS research is to explore the possibilities for in-line assessment of quality. While we have shown feasibility for non-destructive evaluation of individual fruit quality, there is still a need to evaluate this technology under semi-commercial conditions.

OS 10-2:

NON-DESTRUCTIVE PREDICTION OF SOLUBLE SOLIDS AND DRY MATTER CONCENTRATIONS IN APPLES USING NEAR-INFRARED SPECTROSCOPY

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The soluble solid concentration (SSC) is an important factor for assessing quality of apples as it is linked to consumer taste preferences. The fruit dry matter concentration (DMC) is dominated by soluble sugar and starch at harvest, and therefore the DMC at the time of harvest can be strongly correlated with the post-storage SSC. The aim of this study was to develop models using near-infrared (NIR) spectroscopy (729 – 975 nm) to predict SSC and DMC at harvest, and to evaluate the feasibility of NIR models to manage postharvest assessments of apple fruit. NIR spectroscopy was applied to 'Gala', 'Honeycrisp', 'McIntosh', 'Jonagold', 'NY1', 'NY2', 'Red Delicious' and 'Fuji'. Partial least square regression was used to build calibration models for prediction of SSC and DMC. Models were built for each cultivar, and for all cultivars combined. Within individual calibration models, coefficient of determination (R²) values ranged from 0.77 in 'NY2' to 0.86 in 'Jonagold' for SSC, and from 0.60 in 'NY2' to 0.91 in 'Jonagold' for DMC. However, the R² values for calibration of the combined cultivars was 0.88 for SSC, and 0.94 for DMC. The R² value for internal-validation of the combined cultivar



model for all cultivars was 0.90 for SSC, and 0.95 for DMC, and root mean square error (RMSE) was 0.55% for SSC and 4.79 g kg⁻¹ for DMC. In the following year, seasonal and regional effects on the calibration models were investigated. Results for 'NY2' indicated that model performance could be improved by increasing the standard deviation of the calibration set. To obtain sufficiently robust models, calibration should be based on a large dataset rich in variation.

OS 10-3:

RAPID AND NON-DESTRUCTIVE DETERMINATION OF RIND BIOCHEMICAL PROPERTIES OF 'MARSH' GRAPEFRUIT USING VISIBLE TO NEAR-INFRARED SPECTROSCOPY AND CHEMOMETRICS

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Rind biochemical properties play major roles in defence mechanism against the incidence of rind pitting during cold storage. At optimum levels, these properties could enhance fruit appearance and consumer acceptability. However, conventional methods of analysis are destructive and time-consuming. Consequently, a robust visible to near-infrared spectroscopy (Vis/NIRS) based non-destructive models coupled with chemometrics were developed to rapidly determine biochemical properties of 'Marsh' grapefruit rinds using FOSS NIRSystems to acquire spectral information from 400 to 2500 nm. Outliers were identified using principal component analysis and reference parameters were determined using conventional analytical methods. Pre-processing algorithms such as Savitzky-Golay was used to correct light scattering properties of the spectra and methods with best results in terms of higher coefficient of determination (R²), residual predictive deviation (RPD), lower root mean square error of calibration (RMSEC) and root mean square error of prediction (RMSEP) were used for model development. Rind biochemical properties of fruit were analysed using Vis/NIRS and conventional methods before and after 9 weeks of cold storage, respectively. Results obtained using partial least square regression showed good to excellent prediction models for determining properties such as sucrose (R² = 0.99, RMSEP = 0.11, RPD = 11.42), glucose (R² = 0.99, RMSEP = 0.77, RPD = 11.35), fructose (R² = 0.99, RMSEP = 0.99, RPD = 14.23), total phenolics (R² = 0.94, RMSEP = 0.07, RPD = 3.85), total flavonoids (R² = 0.99, RMSEP = 0.07, RPD = 12.37), vitamin C (R² = 0.79, RMSEP = 0.06, RPD = 2.01), radical-scavenging activities (R² = 0.91, RMSEP = 0.17, RPD = 3.07), chlorophylls a (R² = 0.86, RMSEP = 0.08, RPD = 2.53) and b (R² = 0.97, RMSEP = 0.14, RPD = 5.67). These results demonstrated the precision and robustness of models in determining rind biochemical properties of 'Marsh' grapefruit rapidly and non-destructively.

OS 10-4:

THE EFFECT OF 1-MCP APPLICATIONS ON SKIN COLOR AND POLYPHENOL OXIDASE ACTIVITY DURING COLD STORAGE AND SHELF LIFE PERIODS IN 'ANKARA' PEAR (*PYRUS COMMUNIS* L.)

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In this research, the effect of postharvest 1-methylcyclopropane (1-MCP) treatments at different concentrations (150 and 300 ppb) on fruit skin and flesh color, and polyphenol oxidase (PPO) activity of 'Ankara' pear (*Pyrus communis* L. cv. Ankara) was investigated during two consecutive years. Fruit harvested at commercial harvest time were stored at $0\pm1^{\circ}\text{C}$ temperature, 85-90% relative humidity (RH) conditions after 1-MCP treatments at 20°C for 24 hours. In addition, for shelf life determinations, fruit were taken at 30 days intervals and kept at $20\pm1^{\circ}\text{C}$, 60-70% RH conditions for 14 days. During cold storage and shelf life periods, 1-MCP treatments at both concentrations were effective in keeping fruit skin and flesh color, while they helped to decrease PPO activity and to prevent flesh browning. According to the results, it is possible to say that 1-MCP treatment at 150 ppb for a storage period of 200 days and 1-MCP treatment at 300 ppb for longer storage and shelf life periods can be promising treatments for 'Ankara' pear.

OS 10-5:

POSTHARVEST RESPONSE OF PURPLE PASSION FRUITS (*PASSIFLORA EDULIS* F. *EDULIS* SIMS) GROWN UNDER CONTROLLED FERTILIZATION

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The purple passion fruit is an important species in the international market but with scarce basic knowledge about the basis of fruit quality. This work established the contribution to fertilization to gulupa fruit quality. Three stages of maturity (green, semi-ripe and ripe fruits) and five fertilization treatments were tested (0, 25, 50, 100, 150% of the optimal). Quality traits measured were the skin color evaluated by a colorimeter, epicarp hardness, soluble solids, titratable acidity, peel thickness, maturity index, fruit respiration, and citric, malic, ascorbic and oxalic acid content. The two main components of principal component analysis (PCA) were able to establish the main source of variation, particularly the association with fruit maturity (mostly associated with PC1). The PC1 (40.9% total variation) was mainly influenced by chroma skin color index, skin thickness, and soluble solids and was mainly associated with maturity stage and fertilization treatments. The PC2 (21% total variation), was mainly influenced by oxalic and ascorbic acids, which were influenced by the combination of treatments and stages of maturity, and malic acid which varied according to the treatments, but not the different stages of the fruits. A M (ANOVA) confirmed the main effects of the maturity stage and fertilization in the variables selected.

OS 10-6:

DETERMINATION OF COLD STORAGE QUALITY AND SHELF LIFE OF A NEW ASIAN PEAR CULTIVAR CHOJURO NASHI

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The objective of this study was to investigate the cold storage quality and shelf life of a new Asian pear cultivar 'Chojuro Nashi'. We attempted to identify the quality in relation to marketability of the fresh pear fruits affected by controlled atmosphere composition, cold storage and shelf life conditions. For this purpose, pear fruits were transported to the laboratory immediately after harvest. Fruits without injury or decay were selected and divided into two groups. Group 1 (control) was stored at normal atmosphere (NA) condition at 0.5°C temperature and



90-95% relative humidity (RH) at 20.9% O₂ + 0.003% CO₂ for 6 months. Group 2 was stored at controlled atmosphere (CA) condition at 0.5°C temperature and 90–95% RH at 2.5% O₂ + 1% CO₂ for 8 months. During the experiment, fruits were removed from the NA and CA conditions at each analysis period and transferred to the room conditions (20°C temperature and 65±5% RH), where they were kept for 5 days. Fruits were analyzed for weight loss, fruit peel and flesh color, flesh firmness, pH, titratable acidity, soluble solid content, respiration rate, ethylene production and sensorial evaluation (fruit juiciness, sweetness, sourness, flavor, firmness, grittiness, ripeness, internal browning, marketable quality, overall acceptability) during the experiment at 2 months intervals for NA, CA and shelf life conditions. Our findings suggest that ‘Chojuro Nashi’ pear cultivar could be stored at marketable quality for 4 months in NA (5.8 point) and shelf life (5.1 point) conditions. The quality of the fruits maintained better in CA than NA condition. The pear fruits were found at good quality at CA (7.4 point) and shelf life conditions (8.6 point) for 8 months.

OS 10-7:

CFD MODELING OF AIRFLOW INSIDE UNLOADED EVAPORATIVE COOLER, COOLBOT-AIR-CONDITIONER AND COMBINED OPERATIONS

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Postharvest loss of fruit and vegetables is very critical for smallholder farmers. High temperature and low relative humidity are the most important environmental properties that leads to fruit and vegetables deterioration. Low-cost cooling technologies such as evaporative cooling (EC), CoolBot-air-conditioner (CBAC) and the combinations of EC+CBAC were proven to be feasible for cooling of fruit and vegetables in arid and semi-arid regions of developing countries. However, the optimum utilization of this low-cost technologies, is limited due to lack of uniformity in terms of micro-climate air environment inside the store rooms. Cooling of empty storage rooms is critical to determine the heat and mass transfer that takes place inside stores loaded with fresh produces in order to establish the theoretical background in the design process. The Computational Fluid Dynamics (CFD) models can provide a good display of a qualitative visualization of the airflow distribution in side stores. Therefore, an empty EC, CBAC and EC+CBAC were simulated with CFD models. Steady state with isothermal model was used to study the airflow inside the stores subjected to EC, CBAC and EC+CBAC cooling. Validation of the models were performed by comparing the experimental air velocity with that of the computed air velocity at different positions inside the stores. The models fitted well to the experimental velocity values and enabled to clearly characterise air flow patterns in the store. The result displayed that the airflow distribution was non-uniform inside the store which was subjected to all the three cooling methods. EC+CBAC was found to be the best in uniformity of the air distribution, which was followed by CBAC and EC, respectively. Based on the results obtained in this study, the optimal design of cold stores are required to ensure the uniformity of air distribution of air velocity.

OS 10-8:

EFFECT OF PRE-STORAGE UV-B TREATMENT ON DISEASE RESISTANCE AND HEALTH-BENEFICIAL PROPERTIES OF STORED CARROTS

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Postharvest diseases are a major limiting factor in the long-term storage of carrots. In the absence of a registered fungicide, alternative approaches are required to control diseases during storage. UV-B radiation (280–320 nm) is known to elicit various responses in plants, including antioxidant defense system and synthesis of phenolic compounds. Exposure to high levels can induce the expression of stress-related genes similar to activation of pathogen-defense pathways. The objective of this work was to investigate the potential of pre-storage treatment with UV-B light to enhance disease resistance and health-beneficial phyto-compounds in carrots. Fresh carrots were treated with UV-B (0.0-14.0 kJ.m⁻²) and stored at 4° C. Disease resistance of the treated carrots was determined by challenge-inoculation with *Botrytis cinerea*, 21 days after treatment, and the severity of infection was determined 21 days after inoculation. The titers of phyto-compounds of significance in disease resistance (phytoalexin, 6-methoxymellein (6-MM), polyacetylenes, faltarinol and faltarindiol, phenylpropene, myristicin); the GC-MS secondary metabolite profiles; and the physiological and quality characteristics (respiration rate, electrolyte leakage, weight loss and antioxidant capacity); of the treated carrots were monitored at regular intervals during 6 weeks of storage. There was a significant quadratic dose-response relationship between UV-B dose and resistance to *B. cinerea*, and the hormetic or beneficial dose of UV-B for induction of disease resistance was 7.0 kJ.m⁻², with disease inhibition of about 70 %. The disease resistance strongly related to the accumulation of phytoalexin 6-MM, with the hormetic UV-B dose eliciting an accumulation of about 125 µg.g⁻¹ FW. UV-B treatment also greatly enhanced the accumulation of myristicin, with its titer increasing with increasing dose. Levels of faltarinol and faltarindiol, the preformed antimicrobial compounds were not significantly affected by the treatment. Furthermore, the treatment enhanced the levels of phytochemicals, including phenylpropanoids, terpenoids, and isocoumarins. The initial respiration rate and electrolyte leakage of treated carrots were significantly elevated immediately after exposure with increasing dose of UV-B but gradually decreased to the levels of the control. No significant changes were observed with fresh weight loss and antioxidant capacity in the treated carrots. The results suggest that there is a strong potential for pre-storage treatment with hormetic dose of UV-B not only to preserve fresh carrots by controlling diseases and maintaining quality, but also to enhance the levels of plant protective and health-beneficial phyto-compounds.

SESSION XI: Extension of Storage Duration

OS 11-1:

COMPUTATIONAL FLUID DYNAMICS MODELING OF AIRFLOW INSIDE UNLOADED EVAPORATIVE COOLER, COOLBOT-AIR-CONDITIONER AND COMBINED OPERATIONS

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The cooling of unloaded storage rooms is critical to determine the heat and mass transfer that takes place inside the storage chamber that is later loaded with fresh produce, in order to establish the theoretical background in the design process. The Computational Fluid Dynamics (CFD) models can provide a good display of the qualitative visualization of the airflow distribution inside storage chamber. The purpose of this study was to simulate the air velocity and air distribution inside unloaded low-cost cold storage chamber. Therefore, the airflow inside the empty low-cost evaporative cooler (EC), the CoolBot-air-conditioner (CBAC) and the combined operation EC+CBAC was simulated, using CFD models. The steady state with the isothermal model was used to study the airflow inside the storage chambers subjected to EC, CBAC and EC+CBAC cooling. The results showed that airflow distribution was not uniform inside the storage chamber under all the three cooling methods. However, relatively-speaking, the EC+CBAC was found to be the best in its uniformity of the air velocity and distribution, which was followed by the CBAC and EC, respectively. A validation of the models was performed by comparing the experimental air velocity with that of the computed air velocity at different positions inside the storage chambers. The models fitted well to the experimental velocity values and also enabled them to clearly characterize airflow patterns in the storage chamber. This study clearly showed that CFD modelling is a novel way of identifying the airflow inside cold storage and, hence, it was found to be an appropriate tool, not only for advanced design technology, but also for low-cost technology design. Based on the results obtained in this study,



the optimal design of cold storage chambers is required to ensure the uniformity of air distribution and air velocity, using computational fluid dynamics modelling.

O 11-2:

VARIATIONS IN POSTHARVEST ATTRIBUTES OF DIFFERENT TYPES OF TOMATOES STORED UNDER SHELF-LIFE CONDITIONS

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In this study, beefsteak, heirloom and cluster types of tomatoes were harvested at breaker stage and tomatoes were stored at 20°C temperature with 60±5% relative humidity for comparing their shelf-life performance. Data for the weight loss, fruit color, fruit firmness, titratable acidity (TA), total soluble solids (TSS), chlorophyll content, lycopene content, ethylene production, respiration rate and amount of unmarketable fruits were determined during 21 days of storage. Different types of tomatoes had significant effects on weight loss, L*, h°, fruit firmness, amount of unmarketable fruits, chlorophyll and lycopene content. However, non-significant effects of different types of tomatoes on C*, TSS, TA were observed. Maximum L*, C*, h° values, fruit firmness, chlorophyll content, minimum weight loss, amount of unmarketable fruits, lycopene content, ethylene production and respiration rate were recorded in beefsteak type of tomatoes. Therefore, it can be concluded that beefsteak type of tomatoes had better fruit quality and shelf-life performance than heirloom and cluster type of tomatoes. So, they can be successfully stored with maximal quality for 21 days of shelf-life period at 20°C.

OS 11-3:

NATURAL COATINGS AND ESSENTIAL OILS EFFECTS ON POSTHARVEST QUALITY AND ANTIOXIDANT SYSTEM OF ORGANIC AVOCADO (*PERSEA AMERICANA* MILL CV HASS)

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Avocado (*Persea americana* Mill.) is a commodity highly consumed in America since the pre-Hispanic age. Mexico is the major producer globally with the highest share in the organic market of tree fruits. The most critical food losses in the supply chain take place between farm and fork, due to a lack of, or inadequate strategies oriented to preserve quality and prolong shelf life of vegetable products. Recent evidence supports that the application of natural coatings or the use of essential oils (EO) could contribute significantly to preserve quality and extend shelf life of different crops during storage. The objective of this work was to evaluate the application of a commercial organic coating (Natural – Shine 505-OR®) in combination with oregano and thyme essential oils (3 and 5 ml/l) on avocado postharvest quality (firmness, weight loss, internal and external color) along with total soluble phenols (TSP) and flavonoids (TSF) contents, and its relation with antioxidant activity (DPPH and ABTS methods) during cold storage at 6°C for 21 days. The application of coatings, with or without EO, showed a 1.5% reduction of weight loss and results on 6 fold firmness values compared with control fruits (without natural coating). No positive correlations of secondary metabolites content like TSP and TSF with antioxidant activity were observed in treated fruits. Nevertheless, antioxidant capacity levels did not exhibit nominal reductions during storage at the reported conditions of this work. The application of natural coatings contributed positively to maintain quality parameters and antioxidant activity of organic avocado.



OS 11-4:

EFFECTS OF HOT WATER DIP OR CONDITIONING OF GRAPEFRUIT CV. STAR RUBY QUALITY DURING QUARANTINE TREATMENT AND SIMULATED STORAGE DURATION

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Effects of the hot water application and conditioning treatments on Star ruby grapefruit during quarantine treatment and additional storage regime were investigated in this research. The fruits which were hot water dipped or conditioned before the quarantine treatments then additional storage regime applied in order to simulate the export conditions. After the the quarantine treatment and storage conditions fruit samples were evaluated for quality attributes. Weight loss (%), total soluble solids (%), titratable acidity (%), amount of juice content (%), vitamin C (ascorbic acid mg/100 g), antioxidant activity, total phenolic content, fruit peel color (h°), cold damage, pitting, and the decay amount (%) were determined. Results showed that both hot water dips and conditioning treatment were effective against the cold damage.

OS 11-5:

INFLUENCE OF OXALIC ACID ON POSTHARVEST PHYSIOLOGY OF MANGO AND OTHER FRUITS: A REVIEW

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Climacteric behavior of mango triggered the rapid changes in its various physiological and biochemical quality attributes soon after harvest. These changes result in short shelf life with very narrow postharvest market window. Along with some other organic acid, oxalic acid (OA) has been found to involve in a wide range of metabolic and physiological responses in fruits and vegetables thereby affecting their ripening and senescence processes. OA is a natural and safe organic acid exhibits a high potential in controlling post-harvest losses of horticultural crops which ultimately improve their storage life and quality. However, use of OA remains limited, and therefore it is still necessary to take a chance on its commercial application for most of the fruits. The article provides a detailed review regarding the effect of OA on post-harvest decay and disease resistance. Moreover, its role in ethylene biosynthesis, respiration, fruit softening, ripening, oxidative stress, antioxidant systems and nutritional quality has also been discussed.

OS 11-6:

COMPARISON OF QUALITY ATTRIBUTES OF FIG FRUIT (CV. BURSA SIYAH) HARVESTED AT TWO MATURITY STAGES

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Fresh figs are highly perishable fruit during harvesting, handling, storage and marketing. Harvest maturity of this perishable fruit is one of the most important factors for postharvest management. In this study, Bursa Siyahi figs from Bursa region were harvested at two maturity stages, namely commercial and tree ripe maturity stage. Fruit weight, firmness, soluble solids content (SSC), titratable acidity (TA), SSC/TA rate, lightness (L*), chroma (C*), hue angle (h°), consumer preference, respiration rate and ethylene production were investigated. The fruits harvested at commercial maturity stage had lower quality attribute which affects consumer preference negatively. Furthermore, respiration rate and ethylene production were higher in the fruits harvested at commercial maturity stage.

OS 11-7:

GASEOUS OZONE AND PLANT EXTRACT-BASED EDIBLE COATINGS AS POSTHARVEST TREATMENTS FOR 'HASS' AVOCADO (*PERSEA AMERICANA* MILL.) FRUIT

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There is a high worldwide demand for reducing the use of chemicals on fruit commodities due to the residue levels which results in serious health concerns. Conversely, naturally produced plant products and gases are gaining significant interest to consumers as alternative postharvest fruit treatments. Edible coatings and ozone have been known to have potential in enhancing fruit quality during postharvest fruit storages since they do not pose any health problems after consumptions. However, little has been done in determining the effect of edible coatings under cold ozonated storage in the postharvest quality of avocado fruit. This experiment was conducted to evaluate the potential of using edible coating and gaseous ozone in maintaining postharvest quality of avocado (*Persea americana* Mill.) fruit. Two different edible coatings; namely, ethanolic moringa 2% in carboxymethyl cellulose (CMC, 1%) and Rosemary 2% in CMC 1% were applied in 'Hass' avocado and the fruit was thereafter exposed to two levels of ozone (with and without ozone) in a cold room with delivery air of 5.5 °C for 21 days. The results revealed significant differences between coated and uncoated fruit under ozone and no ozone storage conditions. Coated avocados significantly reduced mass loss ($1.42 \pm 0.06\%$) compared to control ($2.24 \pm 0.09\%$), retained higher texture (44.0 ± 3.88 N) than control (36.0 ± 4.22 N), and slowed down the rate of colour change. These findings demonstrated that edible coatings of moringa and rosemary extracts in CMC plus ozonated cold storage prolong shelf-life and maintain overall quality avocados during postharvest life, therefore it is advisable that they are researched further as potential substitutes of chemical treatments in current use.

OS 11-8:

RESPIRATION AND THE CLIMACTERIC RESPONSE IN TOMATOES

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The physiological definition of climacteric ripening is based on a respiratory climax, which is accompanied by an exponential increase in ethylene production. This relationship between respiration and ethylene induction during climacteric ripening is well documented but not fully understood. mRNA expression of more than 10,000 tomato genes was screened and analyzed in fruit that were treated with the ethylene antagonist 1-MCP. Based on



this screen a gene involved in respiration was silenced by RNAi to about 50% of its native expression in Micro-Tom and Del/Ros tomatoes. As a result, both respiration and ethylene production were reduced, prolonging ripening and decreasing the susceptibility to the pathogen *Botrytis cinerea*.

OS 11-9:

DISCRIMINATION OF TWO EARLY AND LATE RIPENING CULTIVARS USING CHEMICAL INDEXES AND GEL PERMEATION CHROMATOGRAPHY (GPC)

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In order to understand differences between the two early and late ripening cherry cultivars, this experiment was being conducted. Two cultivars of “Lambert” as early and “Takdaneh” as late one were selected. Fruits were harvested at two stages of early maturity and ripened one. The variables of the experiment were of chemical traits of fruits and polymeric characters of fruit cell wall carbohydrate using GPC technique. A randomized complete design was applied to analyse the data. Further to this, ripened fruits were stored for two periods of 7 and 14 days. Fruits were evaluated measuring TSS, total sugar content, titratable acid, fructose, anthocyanin content and carotenoid content of fruit stem. Molecular mass traits of fruit cell wall carbohydrate for the two cultivars at the specific extraction stage were measured. Results indicated “Takdaneh” owned significantly higher total phenol, firmness and anthocyanin while “Lambert” had more TSS at the ripening stage. TSS changes trends during storage period indicated “Takdaneh” had more stable status than “Lambert”. Significantly more carotenoid content of the fruit stem was observed for “Takdaneh” cultivars at 14 days of storage. At the same storage period “Takdaneh” significantly indicated more total sugar while before storage there was no difference between the two cultivars. Mean comparison of molecular weight, number and polydispersity index between the two cultivars at CSF solvent indicated “Takdaneh” possessed more polysaccharides of fruit cell wall both soluble and insoluble at the ripening stage. While, “Takdaneh” owned more cell wall polysaccharides in mature stage rather than ripening stage.



POSTER PRESENTATIONS

P1. EFFECT OF SOME CHEMICAL TREATMENTS ON STORABILITY AND FRUIT QUALITY OF WASHINGTON NAVEL UNDER COLD STORAGE

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Some post harvest applications on citrus are known to have considerable effects on cold storage. Most of the procedures employed are based on chemical applications, leading to several problems such as residue in both internal and external consumption. This work will investigate the effects of the natural substance called 'propolis' on cold storage in Washington Navel orange variety. As a result of our research, we observed that after 7% propolis application (without any adverse effect on fruit quality) fungal deterioration was prevented and the storage resistance was more effective than other applications. The fruit was stored successfully for 3 months. 7% propolis application on Washington Navel has been identified as the best practice in this orange variety.

P2. CHANGES IN FATTY ACID COMPOSITION OF PINE NUTS DURING STORAGE

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Pine nuts, which have a high fat content, can be still stored in the shell for long periods under normal storage conditions. Although there are no major changes in physical properties of pine nuts during storage, it should be researched what kind of changes occur in fatty acid composition. In this study, it was aimed to reveal the changes occurring in the fatty acid composition during the storage of pine nuts. The samples of shelled pine nuts picked from different stone pine gardens in Aydın Province Koçarlı District were stored in the jute sack for 24 months under normal storage conditions. Analysis were performed at the very beginning of storage and regularly after 8 months intervals on in-shell pine nuts by cracking hard-shelled pine nuts. According to analysis done at the beginning of storage, saturated fatty acid ratio was found to be 10.12%, while unsaturated fatty acid ratio 89.57% in pine nuts samples. It has been demonstrated that pine nut oil fatty acid composition is composed of stearic acid, palmitic acid, oleic acid, linoleic acid, linolenic acid and eikosatrienoic acid. The majority of unsaturated fatty acids were oleic (36.50%) and linoleic acids (49.87%) while palmitic (6.48%) and stearic acids (3.34%) were the major oils of saturated fatty acids. At the end of storage, there was no significant change in the ratio of saturated and unsaturated fatty acids, while the content of linoleic acid in unsaturated fatty acids decreased considerably.

P3. APPLE ORCHARD SPRAYING WITH COMMERCIAL SOURCES OF CALCIUM TO IMPROVE FRUIT QUALITY

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The objective this work was to evaluate the effects of sources of calcium (Ca) sprayed at preharvest, on physico-chemical quality and bitter pit control of 'Catarina' apple fruit. The experiments were conducted during three seasons (2004/2005, 2005/2006 and 2006/2007) in a commercial orchard, in Southern Brazil. The experiment followed a randomized block design, with four replicates. The sources of Ca tested were CaCl₂, Calboron, Sett, AminolomFloración, Max Fruit, S-CaB, Cal Super, WuxalCálcio, Orgasol Ca, CalSOL 15, Coda-Ca-L and CodaSal-Plus 2000. The spraying of treatments started at the phenological stage J (green fruit) and finished 30 days before fruit harvest. In 2004/2005, the trees were sprayed every 14 days, in 2005/2006 and 2006/2007, the tree were sprayed every 10 days. Along the three seasons, the fruit were assessed for N, P, K, Ca and Mg contents, weight, yield, starch index, flesh firmness, skin color, soluble solids content (SSC), titratable acidity (TA) and SSC/TA ratio at harvest. The incidence and severity of bitter pit was assessed at harvest (in 2005/2006 and 2006/2007), and after three (in 2005/2006) and five (in 2006/2007) months of cold storage. In all three seasons, the preharvest spraying with different sources of Ca had no significant effect on yield, fruit weight and physico-chemical quality of the fruits at harvest. The control treatment (without Ca) had incidences of bitter pit of 24% and 46% in 2006 and 2007, respectively. Only in 2004/2005, the treatments with CaCl₂, Calboron+CaCl₂, Sett, Calboron and S-CaB increased the Ca content in the fruits. Preharvest sprayings (10 and 15 sprayings) with CaCl₂, Calboron and Sett in 2005/2006, and with CaCl₂ and CalSOL 15 in 2006/2007, reduced the incidence of bitter pit, without significantly changing the fruit contents of Ca, N and K in comparison to the control. The results show that the source of Ca tested did not increase consistently the Ca content in the fruit and had small efficiency to control bitter pit in 'Catarina' apples, with a slightly higher efficiency for CaCl₂ to control the disorder.

P4. EFFECT OF DIFFERENT SPROUTING INHIBITORS ON DIPLOID POTATOES (*SOLANUM TUBEROSUM* GROUP PHUREJA) DURING POSTHARVEST IN COLOMBIA

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Potato (*Solanum tuberosum* L. Group phureja) is an important food crop in Colombia due to its sensory and nutritional attributes. Its name "criolla potato" or "yellow diploid potato" corresponds to the morphology types that develop tubers with yellow skin and pulp. These are adapted to shorter day lengths and exhibit low tuber dormancy and diploid nature ($2n = 2x = 24$). The absence of tuber dormancy in yellow potato is what makes them more perishable than other types of potato, with postharvest losses up to 40%. The balance between gibberellins and abscisic acid determines dormancy duration in potato. Some growth retarders or regulators can prevent synthesis of gibberellins at several stages, which reduces growth mainly by inhibiting cell division in areas of meristematic growth. The objective of this research was to determine, whether growth regulators such as chlopropham, paclobutrazol and trinexapac-ethyl increase tuber dormancy period. Treated tubers were stored at room temperature (20°C). Chlopropham (CIPC) was evaluated at doses of 8, 12, and 20 mg*kg of tubers⁻¹, trinexapac-ethyl at 10, 20, and 30 ml*kg of tubers⁻¹, and paclobutrazol (PAC) at 8, 15, and 35 mg*kg of tubers⁻¹. All treatments were applied by spraying. A single application of treatments was carried out at 2 dah, and a control treatment was evaluated without any application. The most effective treatments (i.e. 20 mg CIPC/kg of tubers and 30 ml PAC/kg of tubers) affected tuber dormancy period. In this sense, breaking of tuber apical bud meristem (TAB-meristem) dominance was observed due to the effect of the sprouting inhibitors. Growth regulators did not affect tuber quality parameters such as specific gravity, dry matter and reducing sugars.

P5. EFFECT OF NITRIC OXIDE-RELEASING CHITOSAN NANOPARTICLES ON STORAGE-KEEPING QUALITY AND ANTIOXIDANT ACTIVITY OF CHERRY

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Both chitosan coating and exogenous nitric oxide (NO) can extend the postharvest life of fruit. In this experiment, GSNO-CS NPs, the nitric oxide-releasing chitosan nanoparticles were prepared by the NO donor S-nitrosoglutathione (GSNO) encapsulated into chitosan nanoparticles (CS NPs) via electrostatic interactions. Characterization of the nanoparticles was carried out by dynamic light scattering and transmission electron microscopy. Freshly harvested cherry fruit were immersed with GSNO-CS NPs for 5 min and then stored at 4 °C for 25 d to investigate the effect of GSNO-CS NPs on storage-keeping quality and antioxidant activity. The results showed that GSNO-CS NPs treated could obviously slow down respiration rates and weight loss. GSNO-CS NPs treated cherry had higher soluble solid content compared with that in control fruit. GSNO-CS NPs treatment inhibited the increase of ethylene release rate of fruit. GSNO-CS NPs enhanced the antioxidant enzyme activities of superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), monodehydroascorbate reductase (MDHAR) and dehydroascorbate reductase (DHAR) throughout the storage period. In addition, GSNO-CS NPs treated fruit exhibited higher levels of antioxidant activity as measured by the scavenging capacity against hydrogen peroxide, superoxide and hydroxyl radicals, and by the reducing power test compared to the control. These results indicate that postharvest application of GSNO-CS NPs immersion can improve the storage-keeping qualities and enhance the antioxidant capacity of harvested cherry fruit.

P6. IMPACT OF PRE-COOLING AND MODIFIED ATMOSPHERE PACKAGING ON STORABILITY OF POMEGRANATE (*PUNICA GRANATUM* CV. HICAZNAR) FRUIT

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Preserving quality to extend availability in the markets are becoming more important as pomegranate production rapidly increases. This study is carried out to assess the impact of pre-cooling and modified atmosphere (MA) packaging on quality changes and pathological and physiological losses in pomegranate fruit. Pomegranate cv. Hicaznar fruit were harvested at full maturity and packed in two different modified atmosphere packages (MA1 and MA2). Fruit were pre-cooled for 24 hours at 3 different conditions; a) pre-cooled at 6°C and 90-95% relative humidity (RH) right after harvest b) at 10°C and 90-95% RH after 2 days of storage at 15°C 70% RH and c) at 6°C 90-95% RH after 2 days of storage at 15°C 70% RH. Packages were sealed after pre-cooling and stored under 6°C 90-95% RH conditions for 5 months. In storage, the weight loss in MA2 package was significantly higher than those in MA1 package. After 5 months of storage, the decay development was higher in MA1 compared to those in MA2. On the other hand, mean sensory quality score of fruit was lower in MA2 at the end of the storage period. The weight loss of fruits pre-cooled immediately after harvest were found lower, however decay development was slightly higher than the fruit pre-cooled after 2 days. Effects of the tested modified atmosphere packages and pre-cooling applications were found similar on in-package atmospheric composition, total soluble solids, titratable acidity, total phenolic contents and antioxidant activity. Limited effects were determined on peel and aril color. The results prove that selecting proper MA packages and pre-cooling conditions according to the storage duration is important to obtain a better performance.

P7. Effects of stepwise cooling and oxygen levels on fruit quality in Summerred apples stored in CA-storage

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The major part of Norwegian apples is marketed within 3-4 months after harvest. ‘Summerred’ is a popular cultivar medium early cultivar in Norway, however, it is known to soften quickly during storage and marketing. Storing apples in low temperature and low oxygen atmosphere will slow down the ripening and the fruit will keep green and firm. Delayed cooling has been reported to reduce susceptibility to develop physiological disorders like scald. The experiment included different strategies in delaying cooling (5 days at 7 °C) and allowing the apples to reach 1% oxygen storage after an intermediate period (5 days) at 3% oxygen. The main focus was on changes in firmness, degreening, scald and fruit rots. The apples were stored for 3, 6 or 9 weeks and analysed for standard fruit quality factors (colour, firmness, DA-index, starch, soluble solids and titratable acidity) as the samples were removed from low temperature and low oxygen storage and after a week at 20°C in regular atmosphere (shelf life). Physiological disorders and fruit rots were registered. In these experiments the fruit quality changes were stonger (poorer quality) in apples kept at 7°C for 5 days before storage at 1 or 4°C compared to apples stored immediately at low temperature. The intermediate storage in 3% oxygen tended to make the apples keep firmer during storage. The stepwise reduction in oxygen content reduced the negative effect of delayed cooling. The effects on standard quality factors were strong. The incidences of scald and fruit rots were low, and the effects of delayed cooling and/or delayed low oxygen storage were weak. The results will be compared to previous ‘Summerred’ storage experiments and experiments with delayed cooling before storage of other cultivars.

P8. EFFECTS OF DIFFERENT MODIFIED ATMOSPHERE PACKAGING ON QUALITY CHARACTERISTICS OF KIWI FRUITS DURING COLD STORAGE AND SHELF LIFE

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This study was carried out to determine the effects of different modified atmosphere packaging (MAP) on quality characteristics of kiwi fruits (*Actinidia deliciosa*) during cold storage and shelf life. In the study, 4 different MAPs were selected as Xtend, Aypek, Fresh and FreshPlus. Kiwi fruits were stored at 0±0.05°C and 90±5% RH during 180 days. Also the fruits were waited at 21°C and 70% RH for shelf life during 5 days. MAPs significantly delayed weight loss of kiwi fruits. Firstly respiration rate increased, but it abruptly decreased after 60 days of cold storage and shelf life. L* values in skin increased, whereas L* values in flesh decreased. Xtend and FreshPlus retarded loss of firmness. Titratable acidity and vitamin C content of MAPs were higher than control. Results of study revealed that MAPs maintained fruit quality during cold storage and shelf life.

P9. THE COMBINED EFFECTS OF DYNAMIC CONTROLLED ATMOSPHERE AND 1-METHYLCYCLOPROPENE ON FRUIT QUALITY OF ‘GRANNY SMITH’ APPLES DURING LONG TERM STORAGE

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In this research the effects of dynamic controlled atmosphere storage and 1-Methylcyclopropane (1-MCP) applications on some quality parameters on “Granny Smith” apple variety grown in Çanakkale- Turkey conditions were carried out. For this purpose fruits harvested from Çanakkale Kepez region in Turkey were stored at normal atmosphere (NA) and dynamic controlled atmosphere (DCA) conditions with 1-MCP treatment



and without any treatment. Storage conditions were between 1°C and 2°C temperature with 85%-90% relative humidity conditions for 2, 4, 6 and 8 months. Fruits were kept for 7 days after each storage period as shelf life. Some quality parameters such as fruit firmness, soluble solids content, titratable acidity, flesh color, superficial scald rate, ethylene production and total phenolic contents were assessed after harvest and each storage period. According to the results all of the quality properties were reduced with storage period. Furthermore, all of the quality properties were kept at significant level in fruits treated with 1-MCP and stored at dynamic controlled atmosphere storage. In addition, significant differences couldn't be fixed between dynamic controlled atmosphere conditions without any treatment and normal atmosphere conditions with 1-MCP treatment. Moreover, significant quality losses were determined in fruits stored at normal atmosphere without 1-MCP treatment.

P10. POSTHARVEST HOT WATER AND SODIUM BICARBONATE TREATMENTS TO MAINTAIN QUALITY AND REDUCE DECAY DEVELOPMENT OF PERSIMMON 'CV HACHIYA' FRUITS IN STORAGE

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'Hachiya' persimmon cultivars are grown commercially in western regions of Turkey. During storage period of persimmon fruits, many physiological and pathological disorders occur. This study was conducted for two years to determine the effects of postharvest heat and sodium bicarbonate treatments on major quality parameters and decay development of 'Hachiya' persimmon fruits. Persimmon fruit were dipped in hot water at 50 and 55°C for 2 minutes or immersed in 2% sodium bicarbonate solution for 2 min. As control treatment, fruits were dipped into water at 20°C for 2 min. Treated fruits were air-dried and placed in commercial plastic boxes and stored at 0.5±0.5°C and 90-95% RH for 60 days. Hot water treatment was the most effective on prevention of decay development compared to the other tested treatments. Especially when the fruits were dipped into 50°C hot water for 2 minutes, the decay incidence was quite low. Fruit flesh firmness, total phenolic content and antioxidant activity of fruit treated with hot water were higher than the control fruit after 60 days of storage. The effects of treatments on total soluble solids, L-ascorbic acid, tannin content, respiration rate and ethylene production were not statistically significant. Results showed that, hot water and sodium bicarbonate treatments exert positive effects on preservation of quality and reduction of decay development of persimmon fruits in cold storage.

P11. EFFECT OF RIPENING INHIBITORY PEPTIDE NOP-1 ON POST-HARVEST DEVELOPMENT AND QUALITY OF TOMATO FRUITS (*SOLANUM LYCOPERSICUM*)

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Worldwide, about one third of all plant food is lost before consumption. For perishable fruits and vegetables, the proportion of this loss is as high as 50 %, mainly caused by maturation and senescence during transport and storage. Therefore, processes which can reduce post-harvest losses by delaying maturation and senescence play an important role in terms of sustainable global food supply. The gaseous plant hormone ethylene is the key



player controlling fruit ripening and senescence. Inhibition of ethylene production and action by chemical substances, can delay maturity in climacteric fruits. Recent studies on the molecular basis of ethylene signaling have shown that signal transduction critically depends on the interaction of ethylene receptors (ETRs) with the downstream signal protein EIN2 (ethylene-insensitive protein 2). A synthetic octapeptide (NOP-1) derived from the endogenous nuclear localization signal (NLS) at the C-terminal end of EIN2 inhibits the critical interaction between ETRs and EIN2 and may induce a maturation delay. As part of a collaborative project of the Bioeconomy Science Center (RIPE, Ripening delay of climacteric fruits by peptides), the influence of fruit surface application of NOP-1 on the maturity development and quality of tomatoes was investigated. The influence of different NOP-1 concentrations (400 µM, 1000 µM, 2000 µM) on tomato ripening and quality was studied, using optical, biochemical and physical parameters. Colour index, chlorophyll degradation, lycopene and β-carotene content and firmness measurements concordantly showed a ripening delaying effect of about 10 days by NOP-1. This was most pronounced at concentrations of 1000 µM NOP-1, whereas concentrations of 400 µM and 2000 µM, respectively, showed no statistically significant effects. At the end of the experiment, NOP-1 treated and control fruits had no significant differences in quality parameters.

P12. EFFECTS OF HARVEST STAGE ON PHENOLICS AND ANTIOXIDANT ACTIVITY OF NEW TURKISH HAZELNUT CULTIVARS

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This study was carried out to determine the oil content, total phenolics, total flavonoids and antioxidant activities (DPPH and FRAP assay) of Tombul, Palaz, Çakıldak, Okay 28 and Allahverdi Turkish hazelnut cultivars harvested at different dates. The bioactive compounds of the hazelnut cultivars were investigated weekly from July 20 to August 31 in 7-day periods. The hazelnuts harvested were dried as natural (on concrete floors and with the sun) to a moisture content of 6%, then samples were stored at + 4°C until analysis were performed. Depending on the progress of the harvest, increases and decreases in oil content, total phenolics, total flavonoids and antioxidant activities were observed. In the first measurement date, the highest oil content was found in the Palaz cultivar, while the lowest was measured in the Çakıldak cultivar. However, in the last measurement date, the highest oil content was determined in Tombul cultivar, the lowest oil content was obtained from Allahverdi cultivar. In the last harvest date, generally, the total phenolics, total flavonoids and antioxidant activity of Çakıldak cultivar was higher than other cultivars. The lowest bioactive compounds were obtained in Palaz cultivar (except for the FRAP test). As a result, it was determined that the oil content, total phenolics, total flavonoid and antioxidant activity varied depending on the cultivars and date. Also oil content, which contributes a great deal to taste, flavor and aroma in hazelnut, was increased due to the delay of the harvest.

P13. COMPARISON OF SOME CONVENTIONAL FUNGUCIDE ACTIVE SUBSTANCES WITH ALTERNATIVE TREATMENTS FOR EXTENDING STORAGE LIFE OF ORANGES

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Potassium sorbate (PS), is one of the most common food additive, in this study effects of individual PS, combined treatments of PS with some fungicide active substances and individual environmentally friendly hot water dipping were evaluated for increasing the storage life of oranges. For this reason, Valencia type oranges (cv. 'BATEM Bahari') were dipped into 2% potassium sorbate (PS) solution (w/v); combination of 2% potassium sorbate (PS) with imazalil (500 ppm)+pyrimethanil (500 ppm) active substance containing fungicide



(PS+IM+PR) solution (w/v); imazalil (500 ppm)+pyrimethanil (500 ppm)+guazatin (500 ppm) active substance containing fungicide (IM+PR+GU) solution (w/v) for 30 seconds. Other group of oranges were dipped into 45°C hot water for 3 minutes. Control fruits were dipped into tap water at 20°C for 30 seconds. After treatments fruits were stored at 5°C temperature with 85-90% relative humidity for 5 months. Various chemical and physical analysis (weight loss, color, TSSC, juice, acidity, total phenol, flavonoid etc.) were performed and fungal decays were examined on the fruits. As a result, highest weight loss was measured in PS treatment and the lowest weight loss were measured in IM+PR+GU solution and hot water treatment. During storage, highest decay percentage were determined in PS and control treatments while the lowest decay were determined in PS combined with imazalil and pyrimetaniil and combinations of 3 active fungicide substance (IM+PR+GU). Highest total phenolic and flavonoid contents were measured in hot water treated oranges. In this study, reduction of conventional fungicide licence doses by half and combined with potassium sorbate was found to be best application for controlling postharvest decays in orange. On the other hand, hot water treatment was found to be enhancing some phytochemicals from health point of view.

P14. APPROACH FOR QUALITY DETERMINATION AND MODIFIED ATMOSPHERE PACKAGING OF FRESH CUT SHELLLED ALMOND KERNELS (CV. MAZETTO)

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In Tunisia, the production of almonds is widely cultivated from the north to the south. Consumers have a big interest in fresh cut green almonds during early summer season. The aim of the present work was to determine the effect of MAP on the quality of fresh cut shelled kernels. 'Mazetto' green almonds were harvested when kernel was completely formed. Cracked, shelled, disinfected and filled in trays (60 g) wrapped with PET films as passive modified atmosphere packaging (MAP), active MAP (90% CO₂ in air) versus a control in air. Quality evaluation was done in processing day 0, 7 and 14 days shelf life; weight loss, color (L*, C*: chroma and whiteness index were calculated), bioactive (total phenols, antioxidant activity) and organic sugars were determined by HPLC. MAP significantly reduced weight loss. Kernel color was affected by MAP conditions compared to control. Phenols and antioxidant activity of kernels were maintained, compared to control there was no significant effect. The most dominant organic sugar in kernels was fructose which was significantly maintained by MAP treatment compared to air stored kernels, glucose and sucrose were not affected by packaging.

P15. ASSESSMENT OF POSTHARVEST LOSSES IN SOME FRESH HORTICULTURE PRODUCE IN TUNISIA

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Food loss and waste were estimated by the FAO around 30 to 40 % in the MENA region and Africa. Fresh horticultural crops are among the products with the highest losses. Within the framework cooperation project between KAFACI and several African countries, a study was carried out in Tunisia to determine postharvest loss levels for three selected crops: tomato, pepper and citrus fruit during all the value chain, from harvesting to retailers. The main causes of losses were also identified. The results showed high levels of losses. Total product losses achieved were 22.5 %, 8.4 % and 12.9 % respectively for citrus fruits, tomato and pepper. These losses were observed during all the value chain, but they were particularly important during harvesting operation and postharvest handling. For citrus fruits, we also observed high losses during cold storage. Physical damages and decay were identified as the main causes of these losses. The positive point of this study is that the major part of



these losses could be reduced by a simple application of postharvest good practices. For that purpose, a postharvest manual was proposed for each crop.

P16. STORAGE BEHAVIOR OF 'CASSAR' CLEMENTINE VARIETY GROWN IN DIFFERENT LOCATIONS IN TUNISIA

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The influence of three growing locations on 'Cassar' Clementine mandarin cultivar fruit quality and storage behavior was studied. 'Cassar' cultivar mandarins were harvested from three main Tunisian citrus fruit production areas: Jendouba, Nabeul and Kairouan. Fruits were treated with Imazalil fungicide and stored up to 60 days at 5°C and 85-90% relative humidity. Fruit quality were evaluated at harvest and after 15, 30, 45 and 60 days of cold storage. Firmness, juice content, total soluble solids, titratable acidity and weight loss were determined. Chilling injury index, electrolyte leakage and SERB damages were also evaluated. Production area showed a significant effect on most of quality parameters at harvest. Cold storage behavior of 'Cassar' mandarins was also significantly affected by production area.

P17. THE YIELDS, QUALITY, AND SHELF LIFE OF SWEET CORN GROWN IN WARM REGIONS OF JAPAN

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Sweet corn is a vegetable that starts to deteriorate shortly after harvest, and the problem of shriveling - a cause of dents and gaps in its kernels, have to be addressed from production through to sales stages. A study conducted by Tsuge et al. suggested that the deterioration of the ears of sweet corn is marked during high-temperature periods. In the present study, 'Gold Rush', a cultivar of yellow types, was cultivated during the summer season in warm regions of Japan and examine the yields of the ears of sweet corn, their quality, and shelf life. A shelf life test was conducted under the following conditions: sweet corn was stored in two types of storage form: "husked cobs", which tends to readily shrivel, and "conventional form" - corn completely covered with the husks, packed in two types of modified atmosphere (MA) film (or at two different internal gas concentrations) at 10°C. The rates of shriveling, reduction in weight, and moisture and sugar contents in the kernels of corn were assessed during the 14 days following harvest. Regarding scores for shriveling, the deterioration of "husked cobs" seven days after harvest was severe and they received five points - the maximum, and "conventional form" and corncobs stored using MA film received three or lower points and were in a marketable state even 14 days after harvest. The weight reduction rate for "husked cobs" three or more days after harvest was 10% or higher, and the rate for corncobs stored using MA film was 5% or lower during 14 days after harvest. The moisture content of the kernels of "husked cobs" continued to markedly decline. However, there was no decrease in the moisture content of "conventional form" and corncobs stored using MA film during 14 days after harvest.

P18. EFFECT OF DYNAMIC CONTROLLED ATMOSPHERES ON VOLATILE COMPOUND PRODUCTION IN 'GRANNY SMITH' APPLES

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This study investigated the effect of dynamic controlled atmospheres (DCA) on the production of volatile compounds in 'Granny Smith' apples. Fruit were stored in dynamic controlled atmospheres (DCA; 0.3-0.5% O₂/1% CO₂) and regular air (control) for 12, 16 and 20 w at -0.5 °C. Gas chromatography-mass spectrometry (GC-MS) was used to analyse the volatile compounds. Total amount of volatiles detected in the control fruit samples were significantly ($p<0.05$) higher than those found in DCA. Production of 1-butanol, 1-hexanol and 1-hexen-ol by fruit stored in DCA were 25%, 45% and 27%, respectively, of the amounts detected in the control. DCA treatments also resulted in higher emission of ethanol compared with fruit stored in RA. Production of 2-methylpropyl acetate by DCA stored fruit was 19% of that produced by the control fruit. Esters were the main volatiles detected (50%). The highest emission of ester volatiles was obtained from the control fruit. The known characteristic flavour volatiles in apples, ethyl hexanoate and hexyl acetate were significantly lower in DCA stored fruit, however, ethyl-2-methylbutyrate was notably higher compared to the control treatment. The TA loss was significantly reduced by DCA treatments compared to normal regular air storage.

P19. APPLICATION OF PRE-COOLING AND 1-MCP TREATMENT TO IMPROVE POSTHARVEST QUALITY ON OKRA (*ABELMOSCHUS ESCULENTUS*) PACKAGED AT THE LEVEL OF RETAIL

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Okra is a very popular vegetable in the world and its popularity is increasing nowadays in Taiwan due to the health benefits. Okra can be kept for only two or three days under ambient temperature after harvesting. Fresh okra deteriorates quickly during storage due to tenderness and a high respiration rate. Consumption market of packaged fresh fruits and vegetables, which are convenient direct-to-consumer products, has increased during the last decades. The aim of this study was to extend the storage limit of okra packaged at retail level by using pre-cooling and 1-MCP treatment. Okra pods were treated by pre-cooling after harvest and 1-MCP (0.5mg/L) for 16 h at 6°C. Okra pods were packaged in bag comprised of 0.03 -mm-thick low density polyester film, salad bowl, and sushi box stored at 12°C. Quality characteristics including color, decay, and chilling injury symptom were checked every week during storage. Results showed that pre-cooling is effective on improving the decay, losses of color and texture of okra pods during storage at 12°C. 1-MCP pretreatment minimized the decays of pre-cooled okra in bag, salad bowl, and sushi box to 14.33, 1.67, and 6.67% respectively after 4-weeks storage at 12°C. Application of pre-cooling and 1-MCP treatment committed to a minimum storage period of 4 weeks of okra pods packaged at retail level with low decay, low weight loss, good color and texture.

P20. DETERMINATION OF CHANGES OF QUALITY ON COLD STORAGE DURATION OF GREEN BEANS

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The opportunities of fresh storage in green beans cv. Atlanta examined which cultivated in Çanakkale province in this research. It is aimed to regulate the sales prices in the green bean which has very short shelf life products and to extend the shelf life to deliver the products to an acceptable quality. For this purpose, green beans harvested in ideal fruit size were stored for 4 weeks in cold storage (control), which has 70°C temperature with



90% relative humidity conditions and different modified atmosphere conditions (MAP) prepared by normal LDPE bags and another type of LDPE with special permeability on water vapor (polypropylene + ethylvinylene). The change in quality characteristics throughout the storage period and the effect of MAP applications determined. Quality parameters such as total soluble solid content (%), titratable acidity (TA%), ascorbic acid content, color changes, phenolic compounds, weight loss, visual quality (1. unmarketable....-3. marketable....5. high quality) were determined. According to the results, green colors of beans turn to yellow, brightness of the color decreased, increasing of SSC and phenolic compounds decreasing of TA and ascorbic acid content were found during cold storage. MAP treatments were more effective on the protection of quality. Also weight loss rate was more than acceptable limit after 10 days stored of control beans the place opposite more low 1% on MAP stored beans. The results suggest that green beans Atlanta cv 10 days stored in cold air storage and extended storage period to 20-25 days on MAP conditions.

P21. THE COMBINED EFFECTS OF MODIFIED ATMOSPHERE AND 1-METHYLCYCLOPROPENE ON QUALITY OF GREEN SOUR PLUMS (*PRUNUS CERACIFERA* CV. PAPAZ) DURING COLD STORAGE

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In this research, the effects of modified atmosphere packaging (MAP), 1- Methylcyclopropene (1-MCP) and the combination of these applications on quality of green sour plums (*Prunus ceracifera* cv. Papaz) were studied. For this purpose, 1-MCP treatments at doses of 625 ppb and 1250 ppb and low-density polyethylene (LDPE) based modified atmosphere packaging applications were materialized on plum fruits. Plums were stored at 1-2°C and 90-95% RH conditions for 20, 40 and 60 days respectively. Some quality parameters such as flesh firmness, soluble solids content, titratable acidity, skin color development and total phenolic compounds were evaluated after each storage period. According to the results, the combination of 1-MCP at dose of 1250 ppb with modified atmosphere packaging was found effective on quality parameters during storage.

P22. PRELIMINARY RESULTS ON HARVEST MARKER IMPROVEMENT IN 'HAYWARD' KIWIFRUIT GROWN IN EAST BLACK SEA REGION OF TURKEY

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Kiwifruit growing in East Black Sea Region of Turkey has increased from day to day and this agricultural production area has made a lot of contribution to the grower's income in this location. On the other hand there is not available data on the proper harvest time of this species for this region. In this research we investigated some fruit quality parameters such as fruit width, length and weight, fruit firmness, titratable acidity, soluble solids content and dry matter during pre-harvest period in order to determine the most suitable harvest criteria and harvest time for this region. For this reason, fruit samples were firstly taken at the end of July and the last sampling time was at the end of November with 15 days intervals. During pre-harvest period, all parameters significantly changed and significant increases were observed not only in physical properties of the fruit but also in soluble solids and dry matter content. Fruit firmness decreased with fruit ripening. Significant relationships determined among the parameters investigated in this research will be detailed discussed.



P23. PREHARVEST SPRAYABLE 1-METHYLCYCLOPROPENE (1-MCP) EFFECTS ON FRUIT QUALITY ATTRIBUTES AND CELL WALL METABOLISM IN 'FUJI' APPLES DURING COLD STORAGE

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The objective of this study was to elucidate the effectiveness of preharvest 1-methylcyclopropene (1-MCP, HarvistaTM) treatment on fruit storability in 'Fuji' apple stored at 0°C in air. Fruit untreated or treated with 1-MCP (250mg·L⁻¹) at 2 or 3 weeks before harvest were held in air for 180days. Fruit quality attributes like the loss of fruit firmness and titratable acidity (TA) was delayed by preharvest 1-MCP treatment and internal ethylene concentration (IEC) was also reduced, compared with control fruit. On responses of cell wall metabolite and enzyme activities, preharvest 1-MCP treatment increased uronic acid content but significantly reduced the enzyme activities of α - and β -galactosidase, compared with control fruit. Overall, this result indicated that preharvest 1-MCP treatment affected cell wall metabolite and enzyme activities and thereby, retained fruit quality attributes during cold storage. This research was supported by a grant from 2017 Research Fund (PJ012455022017) of the Rural Development Administration, Republic of Korea.

P24. MICROBUBBLE WASHING EFFECTS FOR IMPROVEMENT IN STORAGE QUALITY OF LIGULARIA FISCHERI (LEDEB)

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Ligularia fischeri (LEDEB.) TURCZ. is the representative wild vegetable of Gangwon Province. It has a unique sense of smell and the functionality such as antioxidative effect and antimutagenic effect and so on. With a recent increase in the single household spending, the agricultural consumption patterns are small, and the demand for a fresh-cut product is increasing. Accordingly, we conducted this experiment in order to establish a safe and environmentally friendly washing technique for fresh-cut produce development of *Ligularia fischeri*. The sterilization principle of micro-bubble is sterilized by a combination of bacteria with the bubble less than 50 μ m diameter by electrostatic force and the sterilizing ability of hydroxyl group (OH⁻). It created a micro bubble with 40 °C hot water and it lasted one minute, three minutes, and five minutes. After treatment, it was compared to non-washing, general washing water and 200 ppm sodium hypochlorite. The freshness was measured with a score of 0-10. The number of possible sales scores was six points. The freshness preservation period for the sale were 22 days in non-washing, 40 days in micro-bubble treatment for 3 minutes by 40 °C water. The micro bubble treatment extended the length of the storage and did not have brown spots when stored. The total number of bacteria and fungi in micro-bubble treatment decreased slightly compared to the non-washing and cell structure was healthy. We could observe the destruction of bacteria on the leaves of the leaf by micro-bubble treatment.

P25. RECENT ADVANCES IN PREPARATION AND PROCESSING OF SEED SPICES IN INDIA

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Seed spices are low volume high value export oriented crops and India is a major producer and exporter of seed spices and their products. India despite being the largest producer of seed spices could not exploit their value



addition potential as majority of export is in the form of whole spices. There is a great potential for increasing export of Indian spices in the form of value added products. To realize this potential there is need to enhance the quality as per international standard through post harvest technology and value addition at different levels of post production system. The preliminary processing is required to provide better income to the farmer, less losses in transport to urban areas for processing, creation of gainful employment at rural level besides to enhance the processable character of farm produce and to achieve the good quality. Cleaned produce fetch high price in the market always. After threshing and cleaning the produce should be dried below 10% moisture level to avoid the pathogenic infections, insect infestations etc in the storage. Spices can be graded by size, density, colour, shape and flavour. Spices can be graded in to 3-4 grades as per the quality. The packaging has played pivotal role in increasing the price to the produce. Barrier films, vacuumed packs, MAP/ CAP are effective and reliable methods of packing for these commodities to retain quality and shelf life. The extracted compound of spices serves as the alternate to whole and ground spices. They are used in various food products like sauces, confectioneries, beverage, pharmaceutical and perfume industries. Extracted oleoresins have the full aroma, flavour and pungency of fresh or dried spices. The oleoresins and/ or essential oils are encapsulated to keep the full flavour impact of spices over an extended shelf life. The seed spices based beverages such as RTS and squashes have been developed and commercialized. Besides, these several other products such as mouth fresheners/ chews, biscuits, toffees, dill parag, cookies and many more products can be prepared for value addition.

P26. INFLUENCE OF POST-HARVEST PRESERVATION IN COLD CONDITIONS ON THE QUALITY OF PEPINO FRUITS

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Pepino (*Solanum muricatum* Ait.) is a native plant of the Andean region, which is cultivated for its fruits. Although until now commercially it has been almost exclusively grown in its area of origin, there is an increasing interest in its cultivation beyond these areas. In Valencia (Spain) different studies have been conducted with the aim of introducing this crop in local horticulture. Fruits are harvested when they reach the optimal stage for the market, based on the fruit color. After harvesting, fruits remain physiologically active, taking place some metabolic reactions, causing a loss of quality during the post-harvest period. The aim of this study is to determine the influence of post-harvest preservation, stored in cold conditions (10°C, 90% relative humidity), on the morphological (size and weight lose), physico-chemical (color, soluble solid content, firmness, and titratable acid) and biochemical parameters (fructose, glucose, sucrose, total soluble sugars, and starch contents, and disaccharide/monosaccharide sugar ratio) of the fruits. Fruits of three accessions, in two consecutive seasons, were stored in a cold room during 15 and 30 days after harvesting, after which they were analyzed. Fruits were grouped around the three stages of maturation, which can be identified by the color of the skin of the fruit, as: "pale green", "pre-ripe", and "mature". The conditions used in this study have limited the loss of the main quality attributes, without causing damage by cold. There were no differences in the response between the two years and three accessions tested. Fruits only registered a small weight loss during storage, and no significant changes in the firmness of the fruits were detected. Results show that fresh pepino fruits can be stored at 10°C keeping all their properties, due to the low evolution of their sugars. The disaccharide/monosaccharide sugar ratio only increased with storage in the mature state.

P27. EFFECT OF CARBON DIOXIDE MICRO BUBBLES IN COMBINATION WITH CHLORINE DIOXIDE SOLUTION TO REDUCE MICROBIAL CONTAMINATION AND BROWNING OF FRESH-CUT COS LETTUCE (*LACTUCA SATIVA* L.)

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In this research, the effect of Carbon dioxide micro bubbles in combination with chlorine dioxide solution to reduce microbial contamination and maintain the quality of fresh-cut cos lettuce were investigated. Fresh-cut cos lettuce was washed in chlorine dioxide solution (ClO₂) (5 ppm) for 5 min and compared with carbon dioxide microbubbles combined with chlorine dioxide solution (5 mg/L, 5 min) (CO₂-MBs + ClO₂). Fresh-cut cos lettuce washed in water (5 min) were used as control. Treated lettuce was packaged in modified atmosphere packaging (MAP) and stored for 10 days at 4°C. Initially, ClO₂ water and CO₂-MBs combined with ClO₂ reduced the total mesophilic population by 1 log reduction. However, treated lettuce washed in CO₂-MBs + ClO₂ showed lower amount of total bacteria count after 2 - 10 days of storage. Washed with CO₂-MBs + ClO₂ also great inhibited the growth of yeast & mold and coliform bacteria during storage. However, ClO₂ water treatment activated browning symptom as compared with control. However, CO₂-MBs + ClO₂ reduced browning symptom of fresh cut lettuce compared with ClO₂ water alone. The amount of phenolic compounds of the fresh cut lettuce was reduced by CO₂-MBs + ClO₂ treatments. Washing with CO₂-MBs + ClO₂ also reduced PPO activity as compared with wash in ClO₂ alone which is correlated with a lower amount of quinone content during storage. An inhibitory effect of browning enzyme and substrate resulted in a lower browning symptom of fresh-cut lettuce during storage. This result indicated that CO₂-MBs + ClO₂ could be an alternative method to ClO₂ for fresh-cut cos lettuce due to a bacterial inhibitory effect and reduction of the adverse effect of ClO₂ to browning.

P28. EFFECT OF LOW PRESSURE STORAGE ON THE QUALITY OF GREENHOUSE CUCUMBERS

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Freshly harvested cucumbers (*Cucumis sativus*) were stored under low pressure (4 kPa) at 10°C for 7 and 11 days with 100 % RH. Upon removal from low pressure storage and after being transferred to normal atmosphere (101 kPa) at 20°C for 3 days, fruits were assessed for weight loss, flesh rots, colour, firmness and overall acceptability. Fruit weight loss was significantly higher in fruit which stored at low pressure (4 kPa) for 11 days at 10°C than fruits that were stored at regular atmospheres (101 kPa) at 10°C. The effect of low pressure treatment on fruit weight loss was greater after the additional three days storage at normal atmospheric pressure at (101 kPa) at 20°C. There was no difference in flesh rots, flesh firmness and colour retention between fruits stored at low pressure and regular pressure at 10°C for 7 and 11 days. Cucumbers were stored at regular pressure (101 kPa) 20°C for 11 days had highest flesh rots and lowest acceptability compared to other treatments.

P29. POSTHARVEST UV-C TREATMENT AFFECTS PEEL DEGREENING 'KENSINGTON PRIDE' MANGO FRUIT STORED AT 20°C

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Ultraviolet (100-400 nm) irradiation has been reported to have beneficial effect on maintaining the postharvest quality of horticultural produce. Specially, a short-term pre-storage treatment with UV-C (180-280 nm) has been



shown to extend the postharvest shelf-life of many horticulture crops. In these preliminary experiments, mature green 'Kensington Pride' mangoes (*Mangifera indica* Linn.) were exposed to UV-C light at four different intensities, and stored for up to 7 days at 20°C. After storage, fruit were assessed for skin colour, flesh colour, flesh firmness, soluble solids content (SSC), titratable acidity (TA), and overall acceptability. The results showed that following UV-C treatment and storage at 20°C, the level of peel degreening were significantly slower, where this response was dose dependent, with increasing levels of UV-C irradiation resulting in slower peel degreening. In addition, UV-C irradiated fruits remained significantly firmer than untreated fruits, while UV-C treatment also significantly affected the flesh colour, overall acceptability, and SSC and TA levels. These results show that a pre-storage UV-C irradiation treatment has a potential postharvest treatment that can delay the peel degreening and other associated events in 'Kensington Pride' mango fruit when stored at 20°C.

P30. EFFECT ON STORABILITY OF PRE-STORAGE WOUNDHEALING IN CARROT (*DAUCUS CAROTA* SUBSP. *SATIVUS*), SWEDE (*BRASSICA NAPUS*) AND CELEARIC (*APIUM GRAVEOLENS* VAR. *RAPACEUM*)

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Storage losses of Norwegian root vegetables are estimated to 20-30%. The losses are caused by respiration, transpiration and diseases. Managing these processes can partly be done by controlling storage conditions. The presented study is part of the project 'Optimization of produce quality and storage conditions to reduce loss during long-term storage of root vegetables in Norway' (OPTIROOT, 2016-2019). The main aim of this experiment is to gain knowledge on how pre-storage woundhealing affect quality and losses during storage in carrot, swede and celeriac. Material used in storage trials is grown on a loam soil (Cambisol, low erosion risk, moderate natural drainage) (WRB, 2006) in Østre Toten, Oppland, Norway (60.70°N, 10.87°E). Two cultivars of carrot (cv. Nelson and cv. Triton) were grown in 2016 and 2017. Swede (cv. Vigod) and celeriac (cv. Prinze) were grown in 2017 and will be grown in 2018. The roots are stored in small-scale stores where effects of pre-storage woundhealing are tested using seven different temperature strategies (direct to 0 °C vs. 0.2 °C or 1 °C temperature reduction per day) and low/high humidity in carrot (2016/17/18), celeriac and swede (2017/18/19). Storage quality parameters investigated during and after long-term storage (7 months) includes weight loss, respiration and storage diseases. Preliminary results show that wound healing significantly reduced loss due to fungal infections in carrot compared to roots stored at 0 °C immediately. Weight loss was higher with slow temperature decline (0.2 °C per day) and woundhealing at low humidity. Decrease in respiration varied depending on temperature strategy with a faster reduction when carrots were stored immediately at 0°C. These preliminary results show that pre-storage treatment affect root storability during long-term storage.

P31. MICROBIAL AND SENSORY QUALITY OF A THORNY ANDEAN BLACKBERRY (*RUBUS GLAUCUS* BENTH) CULTIVAR

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The "moras de Castilla" (Andean blackberries), are the blackberries most commonly cultivated in Ecuador. They are considered non-climacteric fruit and thus, they are usually harvested at full maturity. They are also very perishable as rapid mold growth occurs during the postharvest period. The aim of this study was to evaluate the effects of harvest maturity and storage temperature on the microbiological and sensory quality of Andean blackberries. Blackberries were harvested at maturity stages 3 (light red) and 5 (dark purple), packed in PET clamshells (200 ± 10 g) and stored under room temperature (18 ± 2 °C) and cold storage (8 ± 1 °C). The analyses were performed on days 0, 3, 6, and 9 of storage for sensory (visual quality, color, aroma, firmness and overall



impression) and microbiological quality (total aerobic mesophiles, psychrotrophes, and yeasts and molds). Molds and yeasts' growth was the main limiting factor for the blackberries shelf-life. The counts for this microbial group continuously increased during the storage period, mainly under room temperature. Psychrotrophes were detected only after 6 and 9 days of cold storage in the more immature fruit and, regardless of maturity stage, mesophiles counts were greater in the blackberries stored at 18 °C. The more mature fruit received higher scores in the sensory analyses and were preferred by the panelists as the blackberries harvested at stage maturity 3 were "too firm" and did not develop their full color and characteristic aroma. Based on our results, and even when the Ecuadorian Quality Standard allows to harvest blackberries when they reach the stage maturity 3, the fruit should be harvested at stage maturity 5 and kept under cold storage as refrigeration was effective in delaying microbial growth and in extending the shelf-life period from 3 days at 18 °C to 8 days in cold storage.

P32. FACTORS AFFECTING ARMAGH BRAMLEY APPLE STORAGE POST DPA (DIPHENYLAMINE) WITHDRAWAL

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Following the withdrawal of Diphenylamine (DPA), Irish Bramley growers lost the facility to store the Bramley for 12 months in controlled atmosphere stores. Manufacturers were grant aided to establish low oxygen stores resulting in a significant advantage over primary producers. Research into improving on farm crop management to reduce losses in storage were undertaken. Farmer perceptions of 'good' and 'poor' orchards under the same management were validated by differences in overall disease levels. *Nectria distissima* was found to be the main disease. Acidified water treatments could not cope with the level of soil contamination on bins coming in from the orchard. Geoxe applied as a drench significantly reduced disease levels in storage, more so with wooden bins than plastic.

P33. A COMPARISON OF THE INFLUENCE OF DIFFERENT LOW-COST COOLING TECHNOLOGIES ON TOMATO COOLING TIME AND TEMPERATURE

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Cooling of fruits and vegetables is very critical for postharvest shelf-life extension. The field heat removal should take place immediately after harvest. Different low-cost fruit and vegetables cooling technologies that were proven to be affordable by smallholder farmers are required to ensure better marketability for reasonably extended period in a supply chain. The aim of this study was to compare the effectiveness of different cooling methods in terms of cooling time requirement of the fresh tomato fruit. The cooling technologies used in this study includes the low-cost evaporative cooling (EC), CoolBot-Air-Conditioner (CBAC) and the combinations EC with CBAC which known to be feasible technologies for low-income farmers in arid and semi-arid regions. Fresh tomato cooling experiment to remove field heat during summer was conducted for 72 hours for each of the EC, CBAC and EC + CBAC storage systems. The results showed that 6, 12-18 and 24 hours were required to reduce the temperature of tomatoes using CBAC, EC + CBAC and EC alone, respectively. The EC, CBAC and EC + CBAC reduced and maintained the micro-environment air temperature inside the coolers to 6 °C, 8-13°C and 19 °C, respectively. The ambient temperature was varied between 34 and 40 °C. Hence, CBAC, EC+CBAC and EC can be from the best to lowest choice order by farmers, respectively, for cooling the fruit by reducing the field temperature after harvest.

P34. EFFECT OF DIFFERENT STORAGE METHODS FOR THE SHELF-LIFE AND THE FUNGAL POPULATIONS OF THE HUNGARIAN SOUR CHERRY VARIETIES



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The modified atmosphere has been widely used for long-time storage of different fruits. The aim of our research was the investigation of the pre-and postharvest techniques in case of the different (Normal, MAP) storages for the control and the treated sour cherry. Different sour cherry varieties were examined during the study: 'Érdi bőtermő', 'Petri', and 'Újfehértói fürtös'. Shelf-life was monitored using disease severity index for detecting the activity of fruit decaying fungi. The incidence of the different fungi were also compared at the end of the shelf-life tests. We concluded that the MAP storage has decreased the decay percentage. Different decay incidence and severity was detected for the different varieties during shelf-life studies at room temperature. The storage also has decreased shelf-life of the fruits of the 'Érdi bőtermő' variety, following 6 weeks between 0-2°C cold storage. The rate of the detected fungal genera reduced following cold storage. The optimization of the storage and the shelf-life of the *Prunus cerasus* fruits providing longer time for availability of fresh fruit with high nutritional value with the help of cold MAP storage. The postharvest techniques of the sour cherry can be developed with the adaptation of the methods used for other stone fruits in Hungary.

P35. IDENTIFICATION OF S-ALLELES IN SELECTED ALMOND GENOTYPES BY PCR BASED MARKER

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Almond is a fruit specie that shows self-incompatibility controlled by S-Allele. Recently, molecular techniques for almonds have been developed to determine self-incompatibility. In this paper, we presented the results of a sub-project belong to main project titled "The breeding of almond rootstocks resistant to biotic and abiotic stress conditions", supported by TUBITAK (The Scientific and Technological Research Council of Turkey). In this sub-project, it was determined the self-incompatibility by molecular markers based on PCR primers in 42 almond genotypes selected from Isparta region (Turkey) as a result of previously breeding study. The identification of S-Alleles will be useful in selecting appropriate parents in breeding studies as well as orchard managements.

P36. OPTIMAL STORAGE TEMPERATURE AND 1-METHYLCYCLOPROPENE TREATMENT COMBINATIONS FOR DIFFERENT MARKETING TIMES OF KORLA XIANG PEARS

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Korla Xiang pear (*Pyrus sinkiangensis* Yü Korla Xiang), which originated from Xinjiang Uygur Autonomous Region in China, is usually harvested in mid-September. It has many valuable characteristics, such as a thin exocarp, crispy flesh, high juice and sugar content, little endocarp, and rich flavor. It has a high profit value, high sales, and the longest marketing duration and is the main pear cultivar exported from China. According to our continuous tracking study, maintenance of green color is the primary indicator of quality in the market evaluation of Korla Xiang pears at present and can generally be achieved through early harvesting and decreasing the storage temperature, but the fruit quality was reduced by early harvesting, and the decreasing storage temperature increased the risk of chilling injury. The objectives of this study were to determine the optimal storage parameters for different storage times and to find ways to preserve the green skin color of pears.



Specifically, we analyzed the effects of the ethylene inhibitor, 1-methylcyclopropene (1-MCP), combined with low temperature on quality and maintenance of the green color of Korla Xiang pears during storage. The research objectives included determining the optimal combination of storage temperature and 1-MCP treatment for different marketing times, and to solve issues related to the storage of Korla Xiang pears, such as poor fruit quality and chilling injury due to early harvesting and decreasing storage temperature, respectively. We found that 1-MCP and/or low temperature reduced the loss of green color at 20°C after being removed from cold storage. In addition, 1-MCP significantly inhibited the decline of titratable acid and ascorbic acid but had no significant effect on fruit firmness and total soluble solids. Low temperature with or without 1-MCP inhibited the release of ethylene, inhibited the decline in the stalk preservation index, inhibited the increase in decay rate and weight loss rate during storage, and inhibited the increase in the core browning index after 225 days of storage. Different storage temperatures had different effects on the quality of Korla Xiang pears. Despite inhibiting ethylene release, a storage temperature of -1.5°C increased the respiration rate. Storage at -1.5°C caused core browning early during storage due to chilling injury, whereas at 2°C core browning occurred late during storage due to senescence. In late storage, 1-MCP had no significant effect on the maintenance of Korla Xiang pear quality at 2°C. Based on these results, we determined the optimal combinations of low temperature and 1-MCP treatment to maintain pear quality while avoiding chilling injury. For different marketing times, the optimal conditions for storage until New Year's Day (a storage duration of 90 days) are 2°C or 1-MCP combined with 2°C. For storage until the Spring Festival (a storage duration of 150 days), the optimal conditions are 0°C or 1-MCP combined with 0°C, and for storage until May (a storage duration of 225 days), the best conditions are 1-MCP combined with -1.5°C.

P37. EFFECT OF DRYING METHODS ON THE RETENTION OF BIOACTIVE COMPOUNDS IN AFRICAN EGGPLANT

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African eggplants also known as the scarlet eggplant are wild relatives of the common eggplant. They belong to the *Solanum* genus and comprises of cultivated species such as the Gboma eggplant (*Solanum macrocarpon* L.), the scarlet eggplant (*Solanum aethiopicum* L.) and *Solanum anguivi*; which are grown mostly in Africa for their fruits and leaves. The health and nutritional benefits of African eggplant has led to its increased demand and hence production. However, increased production is accompanied by increase in postharvest losses due to their perishable nature. Due to the relatively short postharvest life in fresh form, they can be converted to shelf stable forms through processing. Processing, however, can induce changes in the physical and chemical properties. This study investigated the effect of four drying methods (solar, oven, vacuum and freeze) on the retention of total phenolics, beta carotene, antioxidant capacity and lycopene in five African eggplant accessions. Fruits were dried up to ~10% moisture content. The results showed that total phenolics, beta carotene and antioxidant capacity contents were significantly ($p < 0.05$) affected by drying method and drying temperature with freeze drying presenting the highest retention. Overall, 36.26 – 95.05% (total phenolics) and 31.44 – 99.27% (beta carotene) was retained during freeze drying. In the fresh state there was a wide diversity in the analyzed traits among the five accessions. Beta carotene, total phenolic content and free radical scavenging activity ranged between 14.75 ± 0.50 - 29.50 ± 0.77 mg/100g db, 751.21 ± 1.73 - 1363.95 ± 2.56 mg/100g GAE db and 99.58 - 325.61 mg/ml db IC₅₀ value, respectively. The accession S00047 showed highest total phenolics and lowest IC₅₀ value in the fresh state. Lycopene was only detected in the dried samples of the accession manyire green. The findings demonstrate that drying method, temperature conditions and accession may influence the retention of bioactive compounds during preservation of the highly nutritious African eggplant.



P38. BIOCHEMICAL CHANGES OF TOMATOES SUBJECTED TO 1-METHYLCYCLOPROPENE AND ETHYLENE TREATMENT

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In this study, the effects of different postharvest treatments on tomatoes (*Solanum lycopersicum* L. cv. Torry) were investigated. Tomatoes were harvested at breaker maturity stage and they were subjected to 625 ppb 1-methylcyclopropene (1-MCP), 1000 ppm ethylene and 625 ppb 1-MCP + 1000 ppm ethylene combination. After treatments, the tomatoes were stored at 13°C temperature with 85-90% RH for 30 days. Fruit samples were taken at 10 days intervals from the storage room and various physical and chemical analysis, including soluble solids, weight loss, flesh firmness, titratable acidity, skin color (L^* , C^* , h°), respiration rate, ethylene production, ascorbic acid, antioxidant activity, total chlorophyll, total lycopene and total phenolics were determined during the storage and shelf life period. The highest flesh firmness, L^* , h° , total soluble solids, total chlorophyll, ascorbic acid and total phenolic contents were obtained from 625 ppb 1-MCP treated tomatoes. Furthermore, 1-MCP treatment reduced weight loss and the loss of titratable acidity. The lowest total lycopene contents were detected from the 1-MCP+ethylene combination and 1-MCP treatments. During the shelf life period, the highest flesh firmness, total chlorophyll, titratable acidity and ascorbic acid content detected from the 625 ppb 1-MCP treated fruit. 1-MCP treatment reduced the weight loss as well. Whereas, the highest total soluble solids content, L^* , h° and the lowest total lycopene and ascorbic acid contents were determined from the 1-MCP+ethylene combination and 1-MCP treated tomatoes. The highest antioxidant activity was obtained from 1000 ppm ethylene treated tomatoes during both cold storage and shelf life. The results indicated that the 625 ppb 1-MCP treatment was the most effective treatment in prolonging postharvest life and maintaining the quality of 'Torry' tomatoes.

P39. THE EFFECTS OF DIFFERENT ATMOSPHERIC COMPOSITIONS ON DECAY DEVELOPMENT IN FRESH FIG FRUIT HARVESTED AT TWO MATURITY STAGES

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Bursa Siyahi fig fruits were stored at $0\pm1^\circ\text{C}$ temperature with $90\pm5\%$ relative humidity under three different atmospheric compositions (3% O_2 + 10% CO_2 , 3% O_2 + 15% CO_2 , 3% O_2 + 20% CO_2) for 28 days. Fungal and bacterial growth, decayed fruit and decay severity were evaluated during cold storage and shelf life period. Fruits harvested at tree ripe maturity stage had lower fungal development than commercial maturity stage whereas there were no statistically significant differences between maturity stages at shelf life conditions. The lowest in decay development was detected at 3% O_2 + 15% CO_2 while the highest fungal development was found in control groups. The amount of bacteria was higher in the fruits harvested at tree ripe maturity stage. During the cold storage, 3% O_2 + 15% CO_2 and 3% O_2 + 20% CO_2 performed better than the other atmospheric composition for amount of bacteria. The highest decay rate and decay severity were found in the fruits harvested at tree ripe stage. It can be concluded that, for fresh fig fruits 3% O_2 + 15% CO_2 considerably reduced decay development in both maturity stages.

P40. THE EFFECTS OF 1-METHYLCYCLOPROPENE ON THE POSTHARVEST QUALITY OF 'GRANNY SMITH' APPLES STORED UNDER AMBIENT AND COLD STORED CONDITIONS

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In this study, the effects of 1-methylcyclopropene (1-MCP) on postharvest quality of 'Granny Smith' apples under ambient and cold storage conditions was determined. Apples were harvested at optimal harvest stage and 625 $\mu\text{L L}^{-1}$ 1-MCP was subjected to apple fruit at 5°C for 24 h. After 1-MCP treatment, apples were stored either at ambient temperature or at 0°C. for 120 days. Fruit samples were removed from different storage conditions at 30 days intervals for flesh firmness, weight loss, titratable acidity, total soluble solids content, skin color changes (L^* , C^* , h°) and ethylene production. 1-MCP treatments effectively maintained titratable acidity and flesh firmness. Less ethylene production and weight loss were determined in 1-MCP treated fruits as compared to control. However, the effects of the storage conditions on total soluble solids content were not significant. L^* and C^* values of apples increased in all treatment groups, while h° values decreased. 1-MCP treatments were more effective in maintaining green color as compared to control. No superficial scald development was observed in the fruits during both storage conditions. It can be concluded that 1-MCP treatment maintained the postharvest quality of Granny Smith's apples under ambient storage condition.

P41. EFFECT OF SOME BIO-EXTRACTS AND OTHER TREATMENTS ON THE STORAGE LIFE OF KHASI MANDARIN (*CITRUS RETICULATA* BLANCO)

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Citrus is one of the most popular fruit in India and north eastern region of India is one of its centres of origin. In order to mitigate losses during storage, this investigation was conducted to evaluate the efficacy of locally available bio extracts in prolonging the shelf life of Khasi mandarin (*Citrus reticulata* Blanco) fruits. The experiment was laid out in CRD with the following treatments: cold water dip (control), Melia seed extract (MSE) (5%), garlic extract (GE) (10%), waxing (paraffin 0.2%), hot water (50±1°C), MSE (5%)+waxing (0.2%) and GE (10%)+waxing (0.2%). Wax treated fruits showed minimum physiological loss in weight during storage period (upto 50 days). Juice content was least reduced in fruits with hot water treatment and MSE (5%)+waxing (0.2%). MSE (5%) treated fruits gave better results in terms of TSS, titratable acidity, TSS-acid ratio, sugar content, while wax coating of fruits alone or in combination with the bio extracts were found to maintain the fruit weight and juice content and slowing down the ripening (aging) process of fruits. MSE 5% treatment may be recommended for prolonging the storage life of Khasi mandarin for about 3 weeks however for longer duration wax coating (0.2%) may be recommended.

P42. RIND PHENOLICS OF 'BENNY' VALENCIA SWEET ORANGE AS INFLUENCE BY PRE -AND POSTHARVEST FACTORS AND THEIR ROLE IN ALLEVIATING RIND CHILLING AND PITTING SUSCEPTIBILITY

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The South African citrus fruit must be cold sterilised as a phytosanitary measure against fruit flies, especially, the oriental fruit fly (*Bactrocera dorsalis*). However, within the sweet orange group, 'Benny' Valencia oranges are highly susceptible to chilling injury and pitting as the non-chilling rind disorders during cold sterilisation. Therefore, the aim of this study was to investigate the effect of harvest time, postharvest dehydration plus waxing and storage temperature on rind phenolics in order to alleviate manifestation of chilling injury and pitting of 'Benny' Valencia sweet oranges after cold sterilisation. Fruit were harvested at early, mid and late season, thereafter, divided into control (untreated), dehydrated at 25°C ±45% RH, waxed with Citrishine plus dehydrated at 25°C ±45% RH in the laboratory. After treatment, fruit were stored at -0.6 and 4.5°C for 28 days, thereafter, 7 days at ambient temperature. During the 7 days shelf-life, fruit were evaluated for non-chilling and chilling disorders, weight loss, electrolyte leakage and firmness. Thereafter, fruit were peeled and the peel freeze-dried, milled under liquid nitrogen and stored at -21°C for further physiological analysis. Milled flavedo was analysed for free and soluble-conjugated phenolics using a spectrophotometric method. Non-chilling disorder was significantly higher for fruit harvested at late season, while, chilling disorder was higher for fruit harvested at early season, especially, during storage at -0.6°C. Furthermore, dehydration stress without waxing increased manifestation of non-chilling and chilling rind physiological disorders at -0.6°C when compared with 4.5°C storage. With respect to both free and soluble conjugated phenolics, the untreated 'Benny' Valencia fruit showed higher rind phenolics, irrespective of harvest time and storage temperature. Therefore, untreated fruit seem to be naturally responding to cold stress by up-regulating endogenous systems of total rind phenolics. Contrarily, postharvest treatments (dehydration and waxing plus dehydration) suppressed endogenous phenolics synthesis, therefore, poor defence against chilling and non-chilling disorders of 'Benny' Valencia fruit.

P43. HARVEST TIME AND PERIOD OF STORAGE MONITOR QUALITY ATTRIBUTES AND CONCENTRATION OF ELEMENTS IN KIWI FRUITS

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Quality attributes during storage life is considered as an important feature for the kiwifruit. Several factors are involved in maintaining the quality of kiwifruit during storage. In the present study, the effects of storage and status of maturity on chemical traits were examined. The experiment was conducted as a factorial in frame of a completely randomized design. Fruits of both Abbot and Hayward cultivars were harvested in two different maturity statuses. These were TSS of 9 and 12 degrees of Brix. All the harvested kiwi fruits were refrigerated at a temperature of 5°C and a relative humidity of 70% for 4 months. The fruit quality traits were measured for the two harvest times monthly. The fruit traits included were titrable acidity (TA), total soluble solids (TSS), flavor index, ascorbic acid, fruit chlorophyll, carotenoids, total phenolic compounds, total antioxidant capacity, total soluble sugar, firmness, pH of fruit juice and fruit pectin. Results showed harvest time with 12 °Brix had higher quality indicating higher phenolic compounds, antioxidant capacity, carotenoids and vitamin C. Firmness, total soluble sugar, pH, chlorophyll and vitamin C all had decreasing trend during storage. However; decline of the traits was slower in Brix of 12° at harvest time. This process in Hayward was slower than Abbot. Ca had significant positive correlation ($p<5\%$) with TSS and antioxidant capacity and ($p<1\%$) with flavor index. K had significant positive correlation ($p<5\%$) with titratable acidity and significant negative correlation ($p=1\%$) with TSS, antioxidant capacity and carotenoids. Fruits harvested with 12 °Brix presented a better quality showing higher amount of calcium and lower potassium level. In conclusion, monitoring level of the nutrient content can be achieved using option of harvest at correct maturity level.

P44. CHERRY SENESCENCE A RESPONSE TO APPLICATION OF ABA AND PARTIAL SEQUENCE ALIGNMENT OF ALFA MANNOSEDASE GENE



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This research was conducted to chase up physiological characteristics of senescence in two cultivars of early and late ripening of Karaj and Takdaneh cherry cultivars. The effect of ABA (0 and 200 ppm) on fruits of two cultivars of early Karaj and Takdaneh, within a period of 20 days after harvest and every 5 days was evaluated. Firmness reduced as storage period increased for both ABA and control treatment. However, the rate of firmness reduction within ABA treatment was significant (P_{alfamansidase} gene was being traced up in five cherry cultivars including of Early cultivar (ER), Foreign early cultivar (FE), Ghazvin early (GE) and Mid ripe cultivar (MR) and late cultivar (LR). Three primers were designed based on the gene sequence of peach extracted from NCBI. In this respect the DNAs extract from leaves of the samples. The primers could cover to 3100 bp length of the gene. The gene sequences alignments were conducted for the samples using Multalin toulouse software. Based on the data sequence and application of Clustal X and 3 View software programs, the dendrogram was drawn and similarity matrix was calculated. The results revealed more similarity of ER, FE and LR than GH and MR. Finally, GR and MR consisted two separate cluster of the tree.

P45. THE EFFECT OF GASEOUS OZONE AND UV-C IRRADIATION ON STRAWBERRY POSTHARVEST QUALITY

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Strawberries (*Fragaria X ananassa* Duchense) are globally amongst the most important fruits. The fruits are an important source of nutrients and bioactive compounds including vitamins, phenolics, antioxidants and dietary fibre. However, strawberries rapidly lose quality during postharvest and their short shelf-life is a serious challenge facing producers and consumers. Chemical treatments have previously been used to maintain quality and extend the shelf-life of strawberries. However, health implications associated with postharvest use of chemicals on food products have necessitated research on non-chemical postharvest treatments. Gaseous ozone and UV-C irradiation are some of non-chemical technologies that have shown potential in prolonging the shelf-life of various fruits and vegetables. This study investigated the effect of gaseous ozone and UV-C irradiation in maintaining the quality and extending the shelf-life of strawberries. Briefly, strawberries harvested at fully ripe stage were irradiated at 0 or 208.2 $\mu\text{W}/\text{cm}^2$ while the other fruit lot was exposed to continuous ozone treatment. All the fruit was stored at 5.8 °C for 7 days and thereafter followed by shelf-life of 2 days at 25 °C. After storage, respiration rate, fruit mass, decay incidence and antioxidant capacity were measured. Fruit exposed to continuous ozone had significantly lower respiration rate and decay incidence compared to the irradiated or untreated fruit. Moreover, fruit mass and antioxidant capacity were much higher in ozone and UV-C treated fruit. This study has shown the potential of gaseous ozone and UV-C irradiation as non-chemical postharvest treatments for strawberries, however, more research aimed at understanding the mechanism of action used by these treatments is needed.



P46. COMPARATIVE ANALYSIS OF THE VOLATILE FLAVOR COMPOUNDS AND QUALITY OF RED- AND WHITE-FLESHED LOQUAT (*ERIOPHYTUM JAPONICA*) FRUITS

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Loquat can be divided into red and white-fleshed cultivars, according to the colour of the flesh. A combined analysis of correlation of physical and chemical indices, sensory intensity and volatile compounds of Jinhua 1 (JH1, red-fleshed) and Huabai 1 (HB1, white-fleshed) cultivars at six developmental stages, covering immature green to fully ripe was studied. The results showed JH1 stopped growth at the stage of half of maturity, and it was more storable because the firmness of JH1 was higher than HB1. The best CCI (citrus colour index) value of JH1 was 9.505 and HB1 was 4.564, and the corresponding CCI value can be used as the reference of harvest under no technical damages for JH1 and HB1. JH1 also matured earlier than HB1. However, soluble solids content of HB1 was higher than JH1. Gas chromatography-mass spectrometry (GC-MS) combined with headspace-solid phase microextraction were applied for identifying the volatile flavor compounds. 133 volatiles were detected in the peel both JH1 and HB1, of while 121 were identified in the loquat flesh. 2-methyl butanoic acid and benzaldehyde were the only cultivar-specific volatile compounds, detected only in JH1. Nonanal and octanal were identified in each maturity stage. In the peel, the content of 14 volatiles were shown increasing trend, and the content of hexanal, β -cyclocitral steadily increased from immature green to complete ripening. On the contrast, 28 volatiles were trending downward during ripening. Among them, the content of (E)-2-hexenal and octanal was higher than others. In the flesh of loquat, the 24 volatiles were growing steadily. 18 volatiles including Hexanal and (E)-2-hexenal were descending. At the same time, (E)-2-octenal, 1-octen-3-one and so on total 6 volatiles were rising at first, then declining. The aroma sensory of JH1 was fruity due to the positive correlation between aroma intensity and fruity compounds. And the grassy aroma components including (E)-2-hexenal and hexanal, which shown positive correlation to aroma intensity, lead to the faint scent for HB1. The results provide suggestions for red and white-fleshed loquat breeding.

P47. THE EFFECT OF DESULPHURIZATION ON SULFUR METABOLISM IN ARIL OF SULFITATED 'HEIYE' LITCHI FRUITS

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Investigated the effect of desulfurization on the postharvest quality, sulfite residue and the activity of enzymes and expression of genes related to sulfite degradation in aril of sulfited 'Heiye' litchi. The litchi fruit was fumigated with sulphur for 25 min (S treatment), and then dipped with 3% desulfurization agent for 4 min (DS treatment). The L* value of the desulfurated fruits was parallelly lower than that of the sulfited fruits but higher than that of the control fruits. The pericarp browning index and rotting rate of 'Heiye' litchi was significantly decreased after sulphur fumigation, and desulfurated fruits. The water content in pericarp decreased and the relative electroconductibility of pericarp increased after sulphur fumigation, while a lower water content and higher relative electroconductibility were found in desulfurated fruits. The sulfite residue in sulfited litchi pericarp reached 486.5 mg kg⁻¹ FW at 0 DAS and then decreased to 226.5 mg kg⁻¹ FW at 48 DAS, while that in desulfurated litchi pericarp was only 248.1 mg kg⁻¹ FW at 0 DAS and then decreased to 82.14 mg kg⁻¹ FW at 48 DAS. The sulfite residue in sulfited litchi aril reached highest level (29.2 mg kg⁻¹ FW) at 16 DAS and then decreased to 11.8 mg kg⁻¹ FW at 48 DAS, while that in desulfurated litchi aril was only 10.7 mg kg⁻¹ FW at 0 DAS and then decreased to be slightly higher than that in control. The activity of SO in the sulfited litchi aril and desulfurated litchi aril was more than 2 folds higher than that in the control litchi aril. The activity of SAT in the sulfited litchi aril was 8.6 to 30 folds higher than that in the control litchi aril, while that in the desulfurated litchi aril was 11 folds higher than that in the control litchi aril at 0 DAS but showed no significant difference to



that in the control litchi aril after 32 DAS. The activity of SiR and OAS-TL in both of the sulfitated litchi aril and desulfurated litchi aril were totally slightly higher than that in the control litchi aril. The expression of SO, APR, SiR, SAT and OAS-TL in both of the sulfitated litchi aril and desulfurated litchi aril was significantly lower than that in the control litchi aril at 0 DAS to 8 DAS, afterwards, the expression of SO, SiR and SAT in the sulfitated litchi aril was totally higher than that in the control litchi aril, while the expression of SO, APR, SAT and OAS-TL in the desulfurated litchi aril was totally higher than those in both of the control litchi aril and the sulfitated litchi aril. The adverse effect of sulphur fumigation on the pigmentation of 'Heiye' litchi was alleviated by desulfurization which accelerated the recovery of coloring and achieved effect similar to sulphur fumigation on controlling rot and keeping quality. Desulfurization greatly reduced the sulfite residue in the peel and aril of sulfitated litchi, so as to ensure its edible safety. After be desulfurated, no significant change was found in the SO activity but the amplitude and duration of increase of SAT activity was reduced in sulfitated litchi aril which indicated that the SO enzyme is the direct and stable way for degradation of sulfite in litchi aril while the reduction pathway may be a complement.

P48. IMPACT OF MATURITY STAGE ON POSTHARVEST QUALITY OF STRAWBERRIES COLD STORED FOR FRESH CONSUMPTION

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Maturity stage plays a key role in determining fruit quality at harvest, efficacy of postharvest treatments and storage expectancy of fruits and vegetables. In supply chain of strawberry, a non-climacteric and highly perishable fruit, mix of fruits at different maturity stages favours rapid spoilage, high mechanical damage and fungal infection that results in short shelf life and high postharvest losses. So, in this study, impact of maturity stage on fruit quality during storage and contribution of fruits harvested at various maturity stages in postharvest losses was assessed. Strawberry (*Fragaria × ananassa* Duch., cv. Chandler) fruits harvested at unripe, semi ripe, full ripe or overripe maturity stages were stored at 5°C and evaluated for changes in fruit quality attributes every alternate day. Red ripe fruits retained highest fresh fruit weight during cold storage. Overripe fruits decayed faster reaching 50% being unmarketable after 10 days of storage compared to red ripe category having only 10% unmarketable fruit. Early decay in overripe fruits was also due to loss of cell integrity as indicated by high ion leakage from 4th day of cold storage. Unripe and semi ripe fruits generally achieved low organoleptic scores due to higher total titratable acids whereas red ripe fruits were organoleptically more acceptable and retained higher total soluble solids compared to unripe, semi ripe or overripe fruits. Over-accumulation of sugars in overripe fruits also favoured high incidence of pathogen infection and spoilage of these fruits. In conclusion, results suggest that maturity stage plays a key role in determining fruit quality and market life of strawberry fruit. Harvesting of fruits just at red ripe stage (when 75% surface develops red colour) not only reduced postharvest losses but also maintained fruit quality for longer period in storage compared to fruit picked at either immature or overripe stage.

P49. ASSESSING THE SHELF-LIFE OF LEAFY SALADS BY ANALYSIS OF VOLATILE ORGANIC COMPOUNDS (VOCs) IN THE RETAIL AND DOMESTIC ENVIRONMENT

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Current methods to predict shelf-life are not sufficient, evidenced by the proportion of wastage in this product category; fresh vegetables and salad accounted for almost a quarter of all avoidable food waste by weight in 2009 (Quested et al., 2011). Wastage occurs when a pack reaches its stated display until date and has to be thrown away, even when the crop is still viable for consumption. Wastage also occurs when the crop fails to hold quality until its display until date and the consumer throws it away. Producing a technology to dynamically assess the state of the product, and the degree to which it has progressed along the shelf-life continuum could lead to less wastage. Identifying and measuring Volatile Organic Compounds (VOCs) that are in the headspace (HS) of the product will allow for dynamic information about the state of the product to be acquired, without the need for destructive testing. The primary objective of the project is to define the shelf-life of pre-packed salad leaves and to link progression of shelf life deterioration to measurable changes occurring within the pack. Single-line leafy salads (rocket, spinach, lettuce) were packed in commercial film bags and maintained in shelf life conditions that mimic those found in a retail store or domestic environment. VOCs present in the HS were adsorbed onto a fiber coated with an adsorbent material such as polydimethylsiloxane, then desorbed and measured by gas chromatography and mass spectrometry (GCMS). Quality markers such as off-aromas, colour and textural defects were measured using GCMS, image analysis and a textural analyser to measure shear force respectively. Specific VOCs were identified from the GCMS data and then correlated with quality markers, providing an insight into which VOCs could be the most informative.

P50. EFFECT OF OZONE APPLICATION DURING SHORT PERIOD COLD STORAGE ON BIOACTIVE COMPOUNDS OF APPLE FRUIT

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Recently ozone has been used to decrease postharvest disease in different fruit. The advantages of ozone include a more effective function against a wide range of microorganisms and the fact that it does not result in any chemical residues. The effects of different ozone treatments combined with cold storage on concentrations of triterpenes, phenolic compounds as well as quality attributes in 'Amorosa' apple were investigated. The concentrations of triterpenes and phenolic compounds were determined by high performance liquid chromatography. The results showed that overall the changes caused by ozone treatment were within the range of fluctuations normally occurring in untreated apples during storage. Ursolic acid concentration in the apple peel was not affected by any ozone treatment applied before or during storage. For the oleanolic acid in apple peel, the ozone treatments increased its concentration after one month of storage. In the end of one month storage, the concentration of total polyphenolics in the peel was decreased by some ozone treatments.

P51. SELECTION OF EDIBLE COATING WITH ANTIOXIDANT CAPACITY TO EXTEND THE SHELF LIFE OF MINIMALLY PROCESSED EGGPLANTS

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The objective of this study was to select various edible coatings based on polysaccharides (sodium alginate (NaAlg), wheat starch (WS) and corn starch (CS)) and proteins (whey protein isolate (WPI) and soy protein isolate (SPI)), with and without the addition of antioxidants (calcium ascorbate (2% CaAsc) plus citric acid (0.1% CA) or cysteine (0.5% Cys)), and lipid compounds (wheat germ oil (WGO), oleic acid (OA), stearic acid (EA), beeswax (BW) and sunflower oil (SFO)) for minimally processed eggplant. In a first experiment, the coatings were selected based on the physicochemical characteristics of the formulations (pH, viscosity and



emulsion stability) and their effectiveness in controlling browning of fresh-cut eggplant during 24 h at room temperature. The visual evaluation showed greater browning control in the samples treated with the coatings containing antioxidants; while only the coatings based on WS and WPI without antioxidants showed a slight antibrowning effect on the fresh-cut eggplants. Based on these results, WS, WPI and SPI edible coatings, with and without antioxidants (CaAsc + CA or Cys) and lipids (OA or WGO) were evaluated in a second test. These formulations were applied to fresh-cut eggplants and samples were stored for 24 h at 20°C with perforated film to evaluate coating's effect on the visual quality and color. In general, the highest luminosity and lowest enzymatic browning were observed in eggplants pieces dipped in edible coatings based on WPI and WS formulated with WGO and antioxidants, while the formulations based on SPI enhanced tissue browning. In addition, in most of the treatments, the antioxidant capacity of Cys was superior to CaAsc + CA. These results show the need to perform preliminary studies to elucidate the effect of the different ingredients used in edible coatings and to optimize their effectiveness in the control of enzymatic browning of fresh-cut vegetables.

P52. COMBINED EFFECTS OF AVG AND MAP ON THE FRUIT QUALITY OF KIWIFRUIT DURING COLD STORAGE AND SHELF LIFE

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This study was carried out to determine the effects of postharvest aminoethoxyvinylglycine (AVG) and modified atmosphere packaging (MAP) treatments on weight loss, respiration rate, color characteristics, fruit firmness, soluble solids content (SSC), titratable acidity and vitamin C of kiwi fruits (*Actinidia deliciosa*) fruits during cold storage and shelf life. In the study, treatments were selected as control, AVG, MAP (Xtend, StePac). Kiwi fruits were stored at 0±0.05°C and 90±5% RH during 180 days. Also the fruits were waited at 21°C and 70% RH for shelf life during 5 days. Kiwi fruits were dipped to solution (125 mg L⁻¹, AVG) for AVG treatment. Weight loss of MAP-treated fruits was lower than control and AVG treatments. Firstly, respiration rate increased, but it abruptly decreased after 60 days of cold storage and shelf life. In skin, L* values increased, whereas chroma values decreased during cold storage and shelf life. MAP and MAP+ AVG treatments delayed losses in flesh firmness. SSC was higher in AVG-treated fruits, whereas it was lower in MAP. Vitamin C content of MAP-treated fruits was higher than control and AVG treatments. Results indicated that MAP maintained fruit quality during cold storage and shelf life.

P53. PHYSICOCHEMICAL CHARACTERISTICS AND SENSORY EVALUATIONS OF MELON MANIS TERENGGANU (*CUCUMIS MELO* VAR INODORUS CV. MANIS TERENGGANU 1) AS AFFECTED BY DIFFERENT STORAGE TEMPERATURES

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Melon Manis Terengganu (*Cucumis melo* L. var. Inodorus cv. Manis Terengganu 1) (MMT) is a newly developed variety in Malaysia. Its postharvest biology and technology's information is still scarce. Hence, this research was aimed at evaluating the effects of different storage temperatures on physicochemical characteristics and quality of MMT. A total of 135 MMT fruits were harvested and further stored for 24 days at different temperatures viz. 5°C, 10°C, 15°C, 20°C and 25°C. The experiment was arranged in a complete randomized design (CRD) with three replications. The changes in weight loss, colour of the MMT skin and flesh, firmness, soluble solid concentration (SSC), titratable acidity (TA), sensory evaluations, ascorbic acid and total phenolic content (TPC) were evaluated over time. Interestingly, MMT stored at 25°C had similar internal and external



qualities as the fruits stored at low temperature storage. In addition, for sensory evaluation, MMT fruits either stored at low or normal temperatures had the same preferences of taste, color, texture and aroma. Moreover, 30 panellists agreed that MMT fruits stored at ambient temperature had the same level of overall acceptance with fruits stored at low temperatures. As a conclusion, MMT fruit can be stored at 25°C for 24 days without significant reduction in its postharvest and sensory qualities as well as fruits stored at low temperature storage. Regardless of temperature, MMT fruits remain acceptable to be sold after 24 days storage. Furthermore, storage time of MMT fruits stored in either at normal or low temperature should be extended as all fruits had a promising postharvest and organoleptic qualities.

P54. NON-DESTRUCTIVE MEASUREMENT OF FRUIT FIRMNESS TO PREDICT THE SHELF-LIFE OF 'HAYWARD' KIWIFRUIT

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Loss of fruit firmness is the most prominent characteristic of postharvest ripening of kiwifruit, which is harvested when mature but still inedible. The commonly used index for harvesting mature fruit is the level of soluble solids (SSC) in the expressed juice generally above 6%. As the harvested fruit softens the SSC increases and the fruit becomes edible at a firmness of about 20N with around 14% SSC. The length of the softening process depends upon several preharvest and postharvest factors. The preharvest factors are not well known, whereas the postharvest ones are harvest maturity, environmental conditions (temperature, relative humidity, composition of the atmosphere) and duration of cold storage. The ability to predict the time till softening would be of considerable commercial value, but to date there is no reliable method to do so. The conventional methods for assessing the progress of fruit ripening, with penetrometer and refractometer, are destructive and hence require a large number of fruit. The objective of this study was to assess the suitability of the non-destructive measurement of fruit firmness with the Sinclair iQ Firmness Tester (SIQFT). 'Hayward' kiwifruit harvested at three stages of maturity from four orchards in two distinct growing areas, at harvest and after cold storage in regular air and controlled atmosphere. Fruit softening was monitored during shelf-life at 20°C by finger pressure, SIQFT and FTA penetrometer (Guss Firmness Texture Analyzer). Highly significant correlations were obtained between iQ units and both firmness assessments. However, the softening pattern with the FTA technique was biphasic whereas that of the SIQFT was linear, thus enabling a prediction of the potential duration of shelf-life.

P55. RESEARCH ON THE EFFECTS OF HARVEST TIME AND 1-METHYLCYCLOPROPENE ON POSTHARVEST QUALITY OF 'EŞME' QUINCE FRUIT DURING LONG TERM STORAGE

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Quince production and consumption displays an increasing trend in recent years, however there is limited data on their post-harvest performance. The quince fruit (*Cydonia oblonga* Mill. Cv. Eşme) were harvested in three different maturity stages according to the skin color and each group were further divided into two groups and either treated with 625 ppb 1-Methylcyclopropene (1-MCP) or not treated (control). Treated and non-treated fruits were stored at 1°C and 90-95% relative humidity conditions for 6 months. During and prior to storage, quince samples were taken at 2 months intervals and then kept at shelf life conditions (20±1°C and 55-65% relative humidity) for 7-days. Major physical, chemical and biochemical quality parameters were analyzed to determine the changes in quality and appearance of physiological disorders. At the end of storage, the weight loss of the fruits treated with 1-MCP was found to be lower. The 1-MCP application limited the loss of green color; however, the differences disappeared as storage was extended. Fruit flesh firmness in non-treated and late



harvested fruits was lower at the end of 6-months storage. The effects of harvest maturity stages and 1-MCP applications on total soluble solids, titratable acidity and pH value, total phenolic content and antioxidant activity were similar at later storage periods. The browning index was reduced significantly with the application of 1-MCP but increased as harvest maturity advanced. The results showed that timely harvests and 1-MCP treatment reduce losses after 6 months of cold storage + 7 days of shelf life by preventing internal breakdown.

P56. DEVELOPMENT OF COATINGS BASED ON WHEY PROTEIN CONCENTRATE AND FENNEL ESSENTIAL OIL FOR ANTHRACNOSE CONTROL AND IMPROVEMENT OF PAPAYA POSTHARVEST QUALITY

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Papaya (*Carica papaya* L.) is a climacteric fruit that has high transpiration rate and intense metabolism during ripening. Therefore, it senesces quickly and it is difficult to store for long periods and consequently postharvest losses are high. This situation is aggravated by postharvest decay caused by *Colletotrichum gloeosporioides*. This research aimed to develop a coating based in whey protein concentrate (WPC), fennel essential oil (FEO), calcium chloride (CC) and glycerol (G) to extend shelf life and maintain the quality of papaya 'Golden'. Besides chemical analysis by GC-MS of the essential oil extracted from *Foeniculum vulgare* Mill, its fungicidal and/or fungistatic effects against *C. gloeosporioides* were investigated. Essential oil was extracted by means of hydro-distillation and afterwards GC/MS analysis was performed to identify their components. Trans-anetol, metil chavicol, fenchona and limonene were detected as main constituents of the essential oil from *F. vulgare*. In vitro, minimal inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) of FEO to reduce mycelial growth of *C. gloeosporioides* was 0.2% (w/v). Coatings formulated with FEO concentrations of 0.2 and 0.4% combined with different WPC (10, 12, 14%), CC (1%) and G (5%) were evaluated using the analysis contact angle, average particle diameter, zeta potential and microscopy. It was found that the most stable coatings were those containing a lower percentage of WPC (10%) and higher FEO concentrations (0.2 and 0.4%). Overall, a whey protein concentrate-based coating formulation (10% of WPC/1% CC/5% G) formulated with 0.2 or 0.4% FEO showed potential to extend the shelf-life and maintain quality of papaya 'Golden'.

P57. GENERAL SITUATION OF HAZELNUT STORAGE PRACTICES IN ORDU (TURKEY)

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32% of Turkey's hazelnut field is located in Ordu (Turkey). It achieves 22% of total production. In Ordu, which has an important place in hazelnut production, there are large and small enterprises related to hazelnut trade. Storage of shelled hazelnuts in hazelnut processing plants is not a common practice. Shelled hazelnuts are stored by producers in the conditions of producers or intermediaries called traders. With this study, information about hazelnut storage applications, encountered problems and also expectation in Ordu province was collected. Negotiations were held for this purpose. As a result, the storage period in Ordu province generally varies between 3 and 10 months. Varieties are mostly mixed stored. It is seen that only a few traders have stored Tombul and Kalinkara hazelnut separately from others. There is natural ventilation in the warehouses. Commonly used jute bags and there is no controlled temperature application. Persons interviewed are divided into two related to licensed storage; abstainers and willings.



P58. EFFECTS OF DIFFERENT TYPE OF PAPER BAGS ON GOLDEN DELICIOUS APPLE FRUITS

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An experiment was conducted to observe first time the effect of pre-harvest fruit bagging on “Golden Delishes” apple variety in Uzbekistan condition. “Golden Delicious” fruit quality parameters were tested after harvesting in September 15, 2017. Apple “Golden Delicious” variety fruits were covered with 2 types of paper bags such as: YGB- inside yellow- outside gray paper bag, NYPB- outside newspaper-inside yellow paper bag. Investigation of “Golden Delicious” fruit parameters showed that control state fruits had a high fruit weight 230.4 gram compared to bagged fruits. The same pattern distinguished by assay height and width of fruits, where control fruits were higher than covered fruits with paper bags. Fruit hardness was measured with a fruit pressure tester FT 327 (Italy) with an 8 mm diameter plunger and revealed that control fruits distinguished with insignificantly low than covered fruits in YGB and NYPB options. Fruits in YGB and NYPB options showed low concentration of soluble solids 15.8 and 15.9%, respectively. Control state fruits showed more high fresh fruit test point 4.6 than bagged, but in fruits which covered with paper bags fruits skin color differed from control fruits with high brightness (Picture). This kind of investigations should be continued in each industrial apple cultivar in Uzbekistan condition by dividing to different option and treatment methods, and more detail study when the use and take off paper bags and how paper bag will effect on growing rate, harvesting time, fruit chemical content, hardness, quality, storage physiological ability and processing parameters.

P59. EFFECTS OF DIFFERENT TYPE OF PAPER BAGS ON CARMEN PEAR FRUITS

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The use of fruit bagging pursues many positive objectives: increased fruit yield and quality of cultivated products, accelerated maturation, improved fruit-setting, mechanical harvesting, and prolongation of postharvest storage life. This kind of experiment is done for first time in Uzbekistan condition in fruits of pear variety Carmen. In Carmen pear cultivar 5 types of paper bags were used such as: WPB- white paper bag, YGB- inside yellow- outside gray paper bag, YPB- yellow paper bag, BPB- double inside black- gray paper bag, NYPB- outside newspaper-inside yellow paper bag. According to assay of Carmen fruits covered with different type of paper bags revealed that all fruits weight covered with paper bags were a little lower than control state. Also, the same pattern was estimated in checking fruit height and width. Fruit firmness was measured with a fruit pressure tester FT 327 (Italy) with an 8 mm diameter plunger and revealed that WPB, YGB and YPB options showed more high hardness on compared to control. BPB and NYPB options distinguished with low hardness in comparison with other states. High content of soluble solids were found in control and WPB fruits than other state, 16,9 and 16,7 %, respectively (table). Also, the highest fruit fresh test point revealed in control fruits. It was investigated that all fruit covered with paper bags before harvesting had a light fruit skin in comparison with control, and, if we will take off the paper bags 10-15 days before harvest can acquires origin red color. This kind of investigations should be continued in each industrial pear cultivar by dividing to different option and treatment methods, and more detail study when the use and take off paper bags and how paper bag will effect on growing rate, harvesting time, fruit chemical content, hardness, quality, storage physiological ability and processing parameters. It is better to use paper bags for mid-late and late ripening period cultivars.



P60. ROBUST MODELS FOR IN-SITU APPLICATION OF PORTABLE VISIBLE TO NIR SPECTROMETER FOR NON-INVASIVE DETERMINATION OF 'VALENCIA' ORANGE (*CITRUS SINENSIS*) FRUIT MATURITY

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Harvest maturity of orange fruits is currently estimated based on total soluble solids (TSS). Juice TSS is analysed from few samples representing the entire orchard using a destructive method based on a refractometer. The technique restricts the number of representative samples due to its destructive nature. Significant loss of fruit occurs if the number of reference samples is increased to properly present huge farms with varying orchard conditions. This study was conducted to develop models for in-situ non-destructive assessment of maturity stage of 'Valencia' oranges using a portable visible to near infrared spectrometer (Felix, F750, Vis-NIR) equipped with a xenon-tungsten lamp as light source and lead-sulphide detector. Previous studies have indicated a change in the operation of spectrometers at different temperatures. As a result, the robustness of models developed in this study was increased by acquiring three spectra from each sample at 10, 20 and 30 °C from morning to early evening. Partial least square regression models for assessing TSS, titratable acidity (TA), maturity index (TSS: TA) and BrimA were developed from spectral and biochemical reference data using The Unscrambler® X software. The models developed were assessed based on high correlation between values predicted during cross-validation and actual values. Model for assessing TSS was successfully developed as indicated by high regression coefficient ($R^2 = 0.988$) and the ratio of performance deviation (RPD = 9.062), and low root mean square error of prediction (RMSEP = 0.114%). Successful models were developed for predicting TA ($R^2 = 0.938$; RPD = 3.150; RMSEP = 0.024), TSS: TA ($R^2 = 0.727$; RPD = 1.522; RMSEP = 0.575) and BrimA ($R^2 = 0.905$; RPD = 3.227; RMSEP = 0.255%) as well. Commercial application of portal spectrometers with the developed models can increase the number of assessed harvest maturity parameters and the number of reference samples since this technique does not need harvesting of sample fruits.

P61. EFFECT OF HOT WATER APPLICATION ON STORAGE AND QUALITY PROPERTIES OF MIHO WASE MANDARIN

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In this study, hot water application in Miho Wase mandarin was conducted for 1 minute at 52°C, 1 minute at 54°C and 1 minute (Control) at 20°C. The fruits were stored for 3 months at 2°C temperature and 90% relative humidity. The weight loss, color change, fruit juice, titratable acidity, total soluble solids, pH, vitamin C (L-Ascorbic acid), total phenolic compounds (mg gallic acid/L), antioxidant activity (%) and decay values of the fruits kept under storage were evaluated periodically. Results showed that hot water application had a positive effect on overall quality parameters of Miho Wase mandarin.

P62. COLD STORAGE OF MANGOES AFTER HOT WATER TREATMENT

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Hot water (HW) fungicidal dip is a common practice in commercial mango consignment preparations. With the increased focus on low temperature shipments (sea-freight to distant markets/refer transport to neighboring countries), the industry oriented question arises about the performance of hot water treated mangoes under cold storage. The mature green fruit of mango cvs. 'Sindhri' and 'Samar Bahisht Chaunsa' ('S.B. Chaunsa') were subjected to hot water treatment (HWT) for 5 minutes dip at various temperatures from 48 to 58°C varying at 2°C (e.g. 48, 50, 52, 54, 56 and 58°C). After HWT, the mangoes were subjected to low temperature storage at 12°C±1°C with 80-85%RH for 21 days in two groups: 'immediately stored after HWT' and 'delayed storage until the pulp temperature of the HW treated fruit was at par with the ambient temperature'. The fruit of mango cv. 'Sindhri' did not have HW scalding up till 54°C; while 52°C in case of cv. 'S.B. Chaunsa'. Overall in both cultivars, the immediate storage after HWT had commercial advantage of having significantly lower weight loss and better physico-chemical quality as compared to delayed storage. Apart from this, studies were also conducted to evaluate the low temperature storage relations with extended HWT which is used as phytosanitary or quarantine treatment for fruit fly disinfestation. The HW phytosanitary treated fruit of mango cv. 'Sufaid Chaunsa' (at 48°C for 60 minutes; or 45°C for 75 minutes compared with control/No HWT) were stored at 10°C with 80-85%RH for a period of 28 days. The HW phytosanitary treated fruit of mango cv. 'Sufaid Chaunsa' had significantly more weight loss and higher rate of respiration as compared to control, thereby having relatively less shelflife; however, physico-chemical fruit quality attributes did not show any negative response. The storage of HW treated mangoes beyond 21 days can sometimes lead towards the pulp splitting which needs to be explored in future.

P63. THE EFFECT OF 1-METHYLCYCLOPROPENE ON STORAGE AND QUALITY PROPERTIES OF KIWIFRUIT FOR FRUIT SLICES

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The effect of 1-Methylcyclopropene (1-MCP) on storage and quality properties of fresh cut kiwifruit slices were investigated in this study. 1-MCP treated fruit were kept at 2°C at 90% relative humidity for 4 months. Freshly cuts were made every 2 months from the fruits kept periodically. Kiwi slices packaged in the study were kept at 4°C for 14 days. Physical and chemical changes such as weight loss (%), flesh firmness (Shore), total soluble solids (%), titratable acidity (%), pH, flesh color (h°), vitamin C (L-Ascorbic acid), appearance were determined in kiwi samples taken at intervals of 7 days during shelf life. Results showed that 1-MCP application had a positive effect on overall quality parameters of kiwifruit slices.

P64. SHELF LIFE OF BROCCOLI IN DIFFERENT PACKAGES STORED UNDER TWO TEMPERATURE REGIMES

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Broccoli (*Brassica oleracea* L. var. *italica*) is a perishable vegetable with limited shelf life, and improved postharvest routines are needed in order to reduce food waste. Although storage at 0-1 °C is recommended, broccoli is commonly exposed to a wide temperature range from harvest to consumption in Norway. The aim of



this study was to evaluate the performance of three different packaging materials for broccoli, with unpackaged product as control, under conditions that simulate transport, distribution, retail sale and consumer storage. Quality and shelf life were evaluated during 16 days of storage in darkness at 4 °C ('Cold storage') or during 4 days in darkness at 4 °C + 3 days in light at 19 °C + 9 days in darkness at 4 °C ('RT storage'). The different packages were 1) biaxially oriented polypropylene (BOPP) flowpack film with 40 micro perforations per package, 2) BOPP flowpack film with a row of 560 needle perforations per 10 x 10 cm in the middle and 3) polyethylene (PE) cling film. The respective weight losses for packaged and unpackaged broccoli were < 1.2% and 16% after 'Cold storage' and < 4% and 27% after 'RT storage'. Temperature had little effect on the firmness of broccoli heads, whereas packaged broccoli retained firmness better than unpackaged broccoli. Development of decay (moulds, soft rot) was observed in all packaged products during 'RT storage'. 'RT storage' resulted in severe yellowing of the broccoli flower buds, whereas packaging had little effect on colour degradation. The results demonstrate the importance of packaging to prevent weight loss and retain firmness in broccoli, but none of the packages tested could prevent yellowing or decay development during the period at room temperature. Hence, to prolong shelf life, broccoli should be packaged and kept cold during the whole distribution chain, including retail display.

P65. THE EFFECTS OF CITRUS AND LEMONGRASS ESSENTIAL OILS ON QUALITY ATTRIBUTES OF APPLES AFTER CONTROLLED ATMOSPHERE STORAGE

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This study was conducted to evaluate the effect of citrus and lemongrass essential oils on antioxidant, phytochemical and physicochemical properties of apple (*Malus domestica*) cvs. 'Granny Smith' and 'Pink Lady'. Fruit was evaluated after thermal fogging with lemongrass and citrus essential oils and storage at controlled atmosphere (-0.5°C; 1.5% O₂ + 1% CO₂) for 28 days followed by 7 days at 20°C. Results showed that 'Granny Smith' apples treated with lemon essential oil alone and lime+lemongrass essential oils retained firmness, while lemon, lime and lemongrass essential oils retained firmness of 'Pink Lady' apples. The titratable acidity of 'Granny Smith' apples treated with essential oils was significantly lower compared to control treatment. However, the titratable acidity of 'Pink Lady' apples treated with essential oils was significantly higher compared to control treatment ($P < 0.05$). The total soluble solid content of both cultivars treated with essential oils was significantly lower compared to control treatments ($P < 0.05$). The total phenolic content of both apple cultivars was higher for all essential oil treatments. Radical scavenging activity of 'Granny Smith' apples treated with lime oil alone, lemon+lemongrass and lime+lemongrass oils was significantly high compared to other essential oils and control treatment ($P < 0.05$), but low for 'Pink Lady' apples. Radical ferric ion reducing antioxidant power of 'Granny Smith' apples was not significantly different from control treatment, while lemon+lemongrass treated 'Pink Lady' apples showed no significant difference ($P < 0.05$). The results suggest that essential oils may maintain fruit quality related attributes in addition to the well documented antimicrobial protection during fresh produce storage and transit.

P66. DETERMINATION OF PHYSICOCHEMICAL PROPERTIES OF DIFFERENT NECTARINE VARIETIES

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Although nectarine is produced in many countries for quite a long time, it became widespread only lately in Turkey. Demand for nectarine fruits is gradually increasing in both domestic and foreign markets, therefore, new varieties are found in the markets. The aim of this research is to determine the physical, chemical and biochemical characteristics of different nectarine varieties as Fresh® Queen and Beauty, May, Red, Sunny, Shine and Globe of Extreme® that are commonly grown in the Aegean region. The average fruit weight, width and length of Globe nectarine variety were the highest with 187.9 g, 70.1 mm and 67.5 mm, respectively; while the lowest values were found as 101.7 g, 55.6 mm and 58.5 mm, respectively in Queen variety. Fruit skin colours showed significant differences, and the colour values of C* and h° ranged between 24.18 - 47.77 and 24.47 - 33.67, respectively, according to the varieties. In this research, Globe had the highest fruit flesh firmness with 58.2 N, followed by Sunny (53.0 N) and Shine (51.0 N) varieties, while the others varied between 40.0-45.0 N. Additionally, the total soluble solids content was the highest in Shine variety with 16.4% and the lowest in May variety (10.7%). Significant differences were observed in total phenol content, antioxidant activity, fructose, glucose and sucrose levels of analysed nectarine varieties. The results obtained from the study showed that the physicochemical properties of nectarine varieties display significant differences.

P67. HOT WATER TREATMENTS COMBINED WITH CALCIUM LACTATE INCREASE ANTIOXIDANT BIOACTIVE COMPOUNDS AND DECREASE MICROBIAL LOADS OF FRESH-CUT PAPAYA

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‘Ekzotika II’ papaya is one of the most common cultivars produced in Malaysia destined for fresh consumption. However, fresh-cut papaya is susceptible to contamination of high microbial populations and depletion of nutritional value during storage. In this work, fresh cut cubes of ‘Ekzotika II’ papayas were immersed for one min in calcium lactate (CaL) 1.5% at 25°C alone or in combination with hot water treatments (50 °C, 55 °C, 60 °C). Phytochemical and microbial analyses were carried out throughout nine days of storage at 5°C. At the end of the storage period, hot water treatments (50 °C, 55 °C, 60 °C) combined with CaL provided papaya pieces with increased total phenolic content (TPC), flavonoid content (FC), ascorbic acid content, total antioxidant activity (TAA), and catalase (CAT) and reduced microbial growth, compared to the control. These treatments could be used to maintain antioxidant bioactive compounds of fresh-cut papaya and increase its storage life.

P68. UNDERSTANDING THE CRITICAL POINT FOR POSTHARVEST LOSSES OF BANANA DURING MARKETING AND DISTRIBUTION IN INDONESIA

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Understanding of postharvest handling losses in each stage and actor along the postharvest handling of banana during marketing and distribution will be useful in determining the priority for postharvest handling improvement. This study aimed to analyze the market chain of banana and to find the critical postharvest losses both of quantitatively and qualitatively in each postharvest stage and actor in Indonesia. Location of the study was in the production center of banana in Cianjur district, West Java province. Quantitative losses were measured from weight losses, and qualitative losses were identified from the quality deterioration occurred along in market chain. The results show that market chain of banana consisted of 3 patterns. First, farmer-collector-retailer-consumer. Second, farmer-collector, big trader-retailer-consumer. Third, farmer-big collector-supermarket-consumer. For the first market chain, the quantitative losses were 15.25% which the highest losses occurred at the collector, i.e., 10.9%. The qualitative losses were 23% occurred in the retailer. For the second market chain,



quantitative losses were 16.74% which the highest losses occurred at the local collector, i.e., 8.41%. The qualitative losses were 57.71% which the highest losses occurred at the local collector, i.e., 48.9%. For the third market chain, quantitative losses were 39.60% which the highest losses occurred at supermarket, i.e., 32.13%. The qualitative losses were 49.96% occurred in the big trader, i.e., 29.36%. This study shows the critical point of postharvest losses in each market chains of banana and indicates who the actor will take responsibility for postharvest losses.

P69. CHLOROPHYLL DEGRADATION, B-CRYPTOXANTHIN ACCUMULATION AND FORMATION OF ORANGE COLOR OF TROPICAL MANDARIN (*CITRUS NOBILIS* LOUR) AFTER POSTHARVEST PRECOOLING AND DEGREENING

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Degreening is the process of breakdown of green color on citrus peel because of chlorophyll degradation followed by formation of orange color as a result of formation and mixture of β -cryptoxanthin and β -citaurin on carotenoids. While pigments contributed on formation of β -citaurin is β -cryptoxanthin and zeaxanthin. The unsuccessfulness of degreening program on tropical citrus to form orange color is because of formation of β -citaurin is only optimum at low temperature. Precooling right after harvest is expected to substitute low temperature that is not available during fruit growth in the field. The aims of this experiment was: 1) to know the effect of precooling and ethylene concentration on orange color formation on degreening experiment, 2) to identify the change of β -cryptoxanthin, zeaxanthin and chlorophyll of orange peel before and after degreening. The mandarin citrus was from Jember, east Java, experiment application and postharvest observation were done at Center for Tropical Horticulture Studies IPB and LIPI Cibinong on February 2014, February 2016 to May 2017. Application precooling and without precooling before injection of 0 (control), 100, 200, and 300 ppm ethylene into degreening box with mandarin citrus inside, expose to ethylene at 20 °C for 24 hours. After exposure, the mandarins were stored at room temperature. The result shows that best peel color is found on application of precooling and 100 ppm ethylene for degreening, that reduce chlorophyll content to 4 folds, increase concentration of β -cryptoxanthin by 3 folds compare to those of degreening without precooling, and change the color to bright orange. Degreening does not have negative effect on internal quality of mandarin.

P70. RETAILING VEGETABLES, A SOURCE OF INCOME FOR NON-FARMER WOMEN OF KATHMANDU NEPAL

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In developing economies, due to urbanization and population increase, retailing fresh vegetables by non-farmers is common. Buying to sell with a profit is not easy when it comes to perishable vegetables. Unequipped with cooling systems, machinery and tools, a vegetable vendor must apply some tactics to sell with a profit. In Kathmandu, buying from street vegetable vendors is mainstream in/near old and new residential areas.





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Supporting such vendors and their small-scale business is considered important to wipe out grass-root poverty. Without much knowledge about post-harvest physiology, they often have to face loss. Yet vegetable vending by these small-scale retailers is convenient for customers and sometimes vegetable vending is the most profitable option for uneducated women who otherwise might need to do more labor intensive jobs. In this preliminary study, we focused on women vegetable retailers at a leading vegetable wholesale market. Our purpose was to gain first-hand knowledge about market conditions, policy and post-harvest provisions at the marketplace to maximize the profit of vegetable vendors. By understanding their challenges, we aim to suggest ways to develop vendor friendly market conditions to stabilize their income through vegetable retailing. Data was collected using an interview style survey with women vendors in 2017. Based on their answers we outlined that basic requirements like permanent vending space, storage facility, constant supply of vegetables, price check, loan provisions, training on vegetable processing, post-harvest techniques, and customer service would enhance their condition. Our results may become reference when establishing new vegetable retail markets.

