

Title 1-MCP can prevent ethylene-induced damage to fruit trees during cold storage
Author F.M. Maas, A.C.R. van Schaik, M.C.J. Hof, R.H.N. Anbergen and M.B.M. Ravesloot
Citation ISHS Acta Horticulturae 884:559-563. 2010.
Keywords pear; *Pyrus communis*; 'Conference'; Smartfresh; 1-methylcyclopropene

Abstract

At present, about 50% of the young fruit trees is stored for more than one month in cold rooms between lifting in the nursery and planting in spring in the orchard with a maximum storage duration of 5-6 months. Storage of fruit trees requires the absence of ethylene in the storage room, as this gaseous plant growth regulator may induce damage to the trees during storage, which eventually may lead to the death of branches or the whole trees after planting the tree in the orchard. In 2007 a series of experiments was carried out to find out the sensitivity of 'Conference' pear trees to ethylene. In addition, the possible use of 1-MCP treatment before storage of the pear trees was examined as a means to prevent ethylene-induced damage. Tree damage was monitored during and directly after storage as well as after planting the trees in the orchard in spring following the storage period in winter. Ethylene-induced symptoms are the discoloration and death of local areas of bark tissue, death of buds and the occurrence of local cracks in the bark followed by the growth of callus tissue. Ethylene-induced damage was observed only when trees were exposed to 5 mg/L ethylene for 1 month at a temperature of 4°C. No damage occurred in case trees were only exposed to this concentration for 1 week at 4°C or for up to 1 month when stored at a temperature of 0°C. Trees treated with 1-MCP before storage did not develop any damage when exposed to 5 mg/L ethylene for 1 month at 4°C, demonstrating that 1-MCP is also taken up by trees harvested after leaf drop. Sensitivity towards ethylene seemed to be dependent on the time of lifting of the trees in the nursery. A trend was observed that trees grubbed in January developed less symptoms after a month exposure to 5 mg/L ethylene at 4°C than trees given the same treatment but lifted in November or March. This suggests that fully dormant trees are less sensitive to ethylene than trees lifted in autumn or spring. Amelioration of the damage after planting the trees in the field was strongly dependent on the amount of damage occurred during storage. Trees with only a little damage recovered quite well, but those with more severe damage often did not recover. Branches or even the whole tree died as result of the damage symptoms developed during storage. Trees treated with 1-MCP before storage showed a normal development after planting in the orchard and were indistinguishable from the untreated control trees. Further research is needed to more accurately determine the concentration, duration and temperature

during exposure at which ethylene becomes harmful to pear trees in storage in order to prevent damage and optimise the use of 1-MCP.

Title Effect of 1-methylcyclopropene and ReTain[®] on quality attributes of 'Kristali' pears after short or long term cold storage

Author G. Pantelidis, M. Vasilakakis and G.A. Manganaris

Citation ISHS Acta Horticulturae 884:323-330.2010.

Keywords *Pyrus communis*; ethylene; respiration; softening; phenols; chlorophyll; antioxidants

Abstract

The effect of prestorage treatment of 'Kristali' pears with two forms of 1-methylcyclopropene (1-MCP) and ReTain[®] on storage performance after various durations of cold storage with subsequent exposures at 20°C was studied. Treatments included immersion in water solutions of 1 mg/L 1-MCP concentration and of 1.28 mmol L⁻¹ ReTain[®], while gas treated fruits were enclosed in airtight plastic chambers for 20 h at 18°C with a 1-MCP concentration of 1 µl/L. Treated and non-treated (control) fruits were stored at 0°C for 0, 2, 4 or 6 months and then held for 4 days at 20°C. Control fruits, after 6 months cold storage and one day maintenance at 20°C, collapsed rapidly. Application of 1-MCP in enclosed area resulted in decreased ethylene and CO₂ production (98 and 45%, respectively) during the four months of cold storage compared to the control. Both forms of 1-MCP delayed fruit softening to a greater extent than ReTain[®] did. L* values were higher in both forms of 1-MCP-treated fruits after 4 or 6 months of cold storage. Hue angle values were higher only in fruits treated with 1-MCP in enclosed areas after 2, 4 or 6 months of cold storage. Soluble solids content of all treated fruits were higher by 6-8% compared to control fruit after 4 or 6 months of cold storage. Chlorophyll content of the peel of fruits after 6 months cold storage was 30% higher in ReTain[®]-treated fruits. Total phenol content and antioxidant activity of all fruits decreased during cold storage, however, all values were higher in treated than in non treated fruits. Overall, our data indicated that when 1-MCP was provided in enclosed areas was the most effective and both forms of 1-MCP gave better quality fruits compared to ReTain[®].

Title Effect of 1-methylcyclopropene on quality attributes of 'Caldesi 2000' white-flesh nectarine during cold storage

Author G. Pantelidis and M. Vasilakakis

Citation ISHS Acta Horticulturae 884:605-610.2010.

Keywords *Prunus persica*, ethylene; respiration, softening; phenols; anthocyanins; antioxidants; peel

Abstract

The effect of postharvest treatment of 'Caldesi 2000' nectarine with 5 µl/L 1-methylcyclopropene (1-MCP, Rohm & Haas Co., Smartfresh 0.14% technology) after several durations of cold storage was studied. Treated with 1-MCP and non- treated (control) fruits were stored at 0°C for 0, 1, 2, 3 or 4 weeks and then held at 20°C for 5 days (shelf-life). Application of 1-MCP resulted in decreased ethylene production after 1, 2 and 3 weeks of cold storage, however, after 4 weeks of cold storage treated fruits produced significantly increased amounts of ethylene. Application of 1-MCP resulted in increased amounts of CO₂ production only in non-cold treated fruits. Application of 1-MCP delayed fruit softening during the first 2 weeks of storage, however, after 3 or 4 weeks of cold storage and 5 days at 20°C there were no differences between treatments. Soluble solids content, after 2 weeks of cold storage, was higher in control than treated fruits, however, after 3 or 4 weeks storage SSC was higher in 1-MCP than in non-treated fruits. Titratable acidity was always significantly higher in 1-MCP treated fruits. Application of 1-MCP resulted in increased amounts of red coloration in the peel of the fruit after 1 week of cold storage. Total anthocyanin content of the peel was 9-35% (1st-4th week, respectively) higher in 1-MCP treated than control fruits. Total phenol content and antioxidant activity of the peel were 4 to 20% higher in 1-MCP treated than control fruits after 1, 2 or 3 weeks of cold storage, however, there were no differences between treatments after 4 weeks of cold storage.

Title Effect of delay between harvest and exposure to 1-MCP on post storage flesh firmness of three apple cultivars

Author M.L. Parker, S.J. McCartney, J.D. Obermiller and T. Hoyt

Citation ISHS Acta Horticulturae 884:611-616.2010.

Keywords *Malus domestica*; SmartFresh; flesh firmness; superficial scald

Abstract

The effects of delay between harvest and exposure to 1-MCP (SmartFresh, AgroFresh Inc.) was investigated for the apple (*domestica* × *Malus* Borkh) cultivars ‘Gala’, ‘Golden Delicious’ and ‘Law Rome’. Each cultivar was harvested at two stages of fruit maturity, based on Cornell starch index values of approximately 4 at the first harvest date and between 5 and 6 at the second harvest date. Harvest fruit maturity and delay between harvest and treatment were within recommended guidelines for commercial use of postharvest 1-MCP on these cultivars. Fruit were held at 0°C immediately after harvest and either not treated or exposed to 1 µl·L⁻¹ 1-MCP for 24 h from zero to seven days after harvest. The efficacy of postharvest 1-MCP treatments was determined by measuring flesh firmness after 40, 80, 120 or 160 days storage in regular atmosphere at 0°C followed by seven days at 20°C. Delaying 1-MCP treatment of ‘Gala’ for seven days after harvest did not influence flesh firmness after storage compared to treating fruit sooner after harvest. Delaying postharvest 1-MCP treatment from one to seven days after harvest reduced its efficacy on ‘Golden Delicious’ and ‘Law Rome’ by approximately 25 and 45%, respectively, when fruit were stored for 40 days after harvest. Although current guidelines for SmartFresh treatment require most apple cultivars to be treated within three to ten days after harvest these data indicate that delaying 1-MCP treatment for seven days after harvest may significantly reduce its efficacy in some apple cultivars.

Title Effect of pre- and postharvest treatments of salicylic and gibberellic acid on ripening and some physicochemical properties of 'Mashhad' sweet cherry (*Prunus avium L.*) fruit

Author M. Gholami, A. Sedighi, A. Ershadi and H. Sarikhani

Citation ISHS Acta Horticulturae 884:257-264.2010.

Keywords ethylene; gibberellic acid; salicylic acid; storage life; sweet cherry

Abstract

The effect of pre- and postharvest treatments of salicylic acid (SA) and pre-harvest treatment of gibberellic acid (GA₃) on physical and chemical properties, ethylene production and ripening indices of sweet cherry fruit were studied. This experiment was carried out in two sections. In the first experiment, five concentrations of SA including 0, 0.5, 1, 2 and 3 mmol/L were used three weeks before harvest as well as at harvesting time and both timing treatments were combined all in three replicates. In the second experiment, four concentrations of GA₃ comprising 0, 10, 20 and 30 mg/L were applied in three replicates. Fruits were sprayed three weeks before harvest when their color started to change from green to yellow. Some fruit quality attributes including ethylene production, flesh firmness, soluble solids concentrations, total acidity, weight and size of fruits were measured immediately after harvest. These measurements were repeated at 7, 14, 21, 28 and 35 days after storing fruits in cold temperature. Statistical analysis showed that, GA₃ treatment significantly delayed fruit ripening while increased fruit size. Ethylene production, flesh softening, weight loss, stem browning, PH and fungal rot of fruits decreased by GA₃ treatment but anthocyanine content and total acidity of fruits increased, so that, 10 mg/L GA₃ caused higher fruit firmness and lower fungal infection. Anthocyanine content, flesh firmness, total acidity and stem freshness of fruits were significantly increased with application of SA, but ethylene production, PH and fungal infection were reduced. In terms of application times, combining pre- and postharvest treatments was the most effective one when 2 and 3 mmol/L SA were used. Both gibberellic acid and salicylic acid treatments kept fruit quality but SA was more effective in decreasing ethylene production and prolonging stem green color compared with the GA₃ treatments.

6 [h061 / b000](#)

Title Ethylene and wine grape berries: metabolic responses following a short-term postharvest treatment

Author E. Becatti, A. Ranieri, L. Chkaiban and P. Tonutti

Citation ISHS Acta Horticulturae 884:223-227.2010.

Keywords postharvest elicitors; secondary metabolism; skin polyphenols; aroma compounds; *Vitis vinifera*; wine composition

Abstract

Even though grape berries are classified as non-climacteric fruit, they respond to exogenous ethylene treatments performed in the field (at veraison stage) or after harvest. Postharvest treatments with gaseous ethylene (1,000 ppm for 36 h) on ‘Sangiovese’ (red-skinned wine grape variety) were effective in inducing marked changes in skin composition considering in particular polyphenols and, more specifically, anthocyanins that appeared to be positively affected at the end of the treatment. The ethylene-induced changes in berry metabolism resulted in a modified composition of the wine where aroma compound (C13, esters, phenols) concentration and ratio of the free/glycosylated aroma compounds were higher than those detected in the wine obtained from untreated berries. These results indicate that grape berries respond to ethylene treatments also after detachment and that the gaseous hormone could be used as postharvest elicitor to improve quality of the wines.

7 [g001 / b006](#)

Title Effect of storage conditions and packaging supplemented with different solutions (wet packing) on vase life of *Gladiolus*

Author P. Munsi, S. Chakrabarty and N. Roychowdhury

Citation ISHS Acta Horticulturae 886:351-357.2011.

Keywords storage duration; packaging; Principal Component Analysis

Abstract

During storage and transportation generally low temperature and high relative humidity (95 to 98%) are beneficial to reduce postharvest loss for most of the cut flowers. Moreover, the best flower turgidity without mechanical damages can be obtained under wet storage or a wet transportation method, i.e., when stem bases of flowers are stored in a container with water or with a floral preservative solution. To explore the applicability of this technique, the present experiment was carried out on *Gladiolus* ‘Sylvia’ at the Post Harvest Technology Laboratory of Bidhan Chandra Agricultural University during 2003-2005. Interactions among the different factors under the present investigation were studied following the method of the Principal Component Analysis. The percent floret display and vase life were higher in flowers wet packed with sucrose 4%, wrapped in polyethylene, up to 48 hours storage, even at ambient

condition. However, for low temperature (10°C) storage, sucrose at 3% was more effective when wrapped with polyethylene. The findings of the present investigation revealed an extra opportunity to avoid cost input for maintaining low temperature by wet packing with 4% sucrose up to 48 hours. During wet packing, apart from maintaining a modified atmospheric condition due to packaging, flowers were continuously being supplied with an energy source by solutions of the pouches with which the cut end of the flowers were adhered. Thus, there was increased viability of flowers in vase due to wet packaging, even after storing at ambient conditions.

8 [g072 / b006](#)

Title Effect of sucrose on postharvest quality of cut *Gloriosa superba* l. 'Misato red' flowers
Author S. Fukai and S. Fujita
Citation ISHS Acta Horticulturae 884:77-82.2011.
Keywords cut flower; flower color

Abstract

Postharvest quality of cut *Gloriosa superba* L. 'Misato Red' flowers was investigated in relation to sucrose in a vase solution. All flower buds on stems opened with equivalently sized perianths and similar flower longevity, irrespective of the initial flower bud size when the cut flowers were kept in a vase solution containing 1% sucrose and germicide at 24°C. Smaller flower buds developed smaller flowers with pale color, indicating that flower buds required considerable energy to develop normally when flower buds were detached from cut flowers. However, sucrose in a vase solution had no effect on flower longevity of detached and fully opened flowers. Flower buds on stems developed larger flowers with bright flower color when the vase solution contained 3-10% sucrose. Pulsing of sucrose was not effective for maintaining flower quality and longevity.

9 [q014; q999; g044; g117 / a008; b005](#)

Title Extending the shelf life of flower bulbs and perennials in consumer packages by modified atmosphere packaging
Author H. Gude, M.H.G.E. Dijkema and C.T. Miller
Citation ISHS Acta Horticulturae 884:99-103.2011.
Keywords dry sale; bare-root; filling material; peat moss; Toresa; moisture content

Abstract

The quality of flower bulbs and herbaceous perennials in consumer packages declines rapidly due to sprouting and drying out. The present study was undertaken to develop Modified Atmosphere Packages (MAP) with suitable filling materials for a prolonged shelf life of different species of flower bulbs (e.g., *Lilium*, *Anemone*, *Erythronium*) and herbaceous perennials (e.g., *Hemerocallis*, *Hosta*, *Phlox*). As filling materials peat moss and Toresa (wood fiber) were tested. So-called continuous MA films were used, i.e., without laser holes, which means that they are virtually impermeable to water. The shelf life of plants and bulbs was tested in packages produced from these films after addition of filling materials with different moisture contents. The shelf life was determined in a climate chamber at 23°C with a high ventilation rate. The same products were packed in traditional packages with microperforation for comparison.

The shelf life of bulbs and perennials was extended dramatically from 3 to 4 weeks in the traditional package with microperforation to 2 to 3 months by the use of MA packaging. It was however not the low oxygen level inside the packages that caused this effect but the reduction of water loss by using MA films. In microperforation packages the products dried out completely in 3 to 4 weeks, whereas in the MA packages the products remained turgid and vital for 2 to 3 months. Sprouting was inhibited by using dry filling materials. The term Modified Humidity Packaging therefore seems to be more appropriate for this type of packaging. To prevent too low oxygen levels inside MA packages it is recommended to use an MA film with a high permeability for oxygen. This also enables the use of one film for a wide range of products.

10 [g004 / b005; b006](#)

Title Influence of packaging material, storage condition and storage duration on vase life of tuberose 'Calcutta double'

Author N. Roychowdhury, S. Chakrabarty (Das) and P. Munsri

Citation ISHS Acta Horticulturae 884:359-364.2011.

Keywords vase life; storage duration; storage condition; packaging

Abstract

In general, as cut flower, tuberose bunches are enclosed in paper or polyethylene sleeves or covers while transporting to distant markets. However, there are very few reports on the effect of different packaging materials, including banana leaf (as frequently used by local farmers) and their interactions with storage temperature, storage duration and subsequent physiological implications under West Bengal

conditions. Addressing this issue, the present experiment was conducted at the laboratory of the All India Coordinated Research Project (AICRP) on Post Harvest Technology at Bidhan Chandra Krishi Viswavidyalaya (BCKV), to study the effect of packaging and storage on vase life tuberose 'Calcutta Double'. Data were analyzed using a completely randomized design. The study revealed that spikes wrapped with banana leaf exhibited maximum vase life with maximum floret opening and least amount of floret wilting. The modified atmosphere inside such packages was having reduced oxygen and elevated carbon dioxide (CO₂), either due to selective permeability to gases (for plastics) or due to active respiration (of banana leaf tissue). Further, spikes stored for 24 hours, especially at 10°C exhibited least floret wilting with better turgidity throughout the vase life. Retarded rate of respiration, transpiration, ethylene production and entire metabolism of the flower tissue as a whole was facilitated by low temperature (during storage) that was exhibited by better performance of flowers in vase.

11 [h042 / b006](#)

Title Effects of Benzothiadiazole on storability and quality of loquat in low temperature
Author Z.W. Zhang, S.J. Zhu, J.J. Zhong, L.J. Zhang, J.H. Cai and X.W. Rao
Citation ISHS Acta Horticulturae 887:357-362.2011.
Keywords loquat; fruit; BTH; flesh firmness; lignifications; relative electrical conductivity; chilling injury; quality

Abstract

Benzothiadiazole (BTH) is a new type of plant protectant that can activate systemic acquired resistance (SAR) in plants. However, there has been little information available about whether or not it affects the performance of fruits stored in low temperature. We observed that BTH treatment delayed the increase of relative electrical conductivity, reduced pulp firmness and lignin content, and maintained higher contents of total soluble solids and titratable acid. These results suggest that BTH reduced chilling injury and maintained fruit quality of loquat stored at low temperature.

12 [h042 / b001](#)

Title Physiological characterization of 'Algeri' loquat maturity: external colour as harvest maturity index
Author C. Besada, R. Gil, P. Navarro, E. Soler and A. Salvador
Citation ISHS Acta Horticulturae 884:351-356.2011.

Keywords loquat; total soluble solids; acidity; fruit quality; mesh screen; colour chart

Abstract

In the loquat growing area of Spain, a minimum soluble solids content of 10 °Brix is required as standard of quality to ensure fruit maturity stage that meets consumer expectations. Nowadays, the maturity index used to harvest is the visual observation of the external colour of the fruit, thus growers experience is decisive to decide the optimum harvesting time. In the present work, the relationship between the changes in the colour of the fruit and the physiological changes that take place during loquat maturation has been established for loquat ‘Algeri’. Eight maturity stages were fixed based on a visible increase in external colour, ranging from stage I (dark green) to stage VIII (dark orange). Immediately after harvest, physiological stage of the fruit was characterized. The changes in colour observed during maturity were linked to an increase in weight, diameter and soluble solids content, as well as to a decrease in firmness, acidity and soluble tannins. No relevant changes were observed in ethylene and respiration rate during maturation, which reflects the non-climateric behaviour of this cultivar. Soluble solids content of 10°Brix was reached between maturity stage SV and SVI, which correspond with an external colour of IC= +3 to +6 (IC=1000a/Lb). Sensory evaluation of acidity and astringency revealed that only fruit harvested after reaching maturity stage SVI were sensory accepted. Thus, to satisfy consumer preferences ‘Algeri’ loquat must be harvested with a minimum external colour of IC= +6. Based on this work, we have developed a colour chart for maturity evaluation that matches the surface colour of ‘Algeri’ loquat, which can be a useful tool to decide the optimum harvesting date.

13 [h042 / b000](#)

Title Recent development in postharvest physiology and storage of loquat

Author S.K. Mitra, I. Chakraborty, D. Majhi and P.K. Pathak

Citation ISHS Acta Horticulturae 884:339-343.2011.

Keywords *Eriobotrya japonica*; metabolism; carbohydrates; biotechnology

Abstract

The fruit of the loquat (*Eriobotrya japonica* Lindl.) has a characteristic colour, texture, taste and aroma at maturity. The harvest maturity for loquat is determined based on peel colour, days from fruit set, firmness and total soluble solid/acidity ratio. The fruit is classified as non-climacteric by most researchers; however, there is a contradiction in this determination. The physiology of fruit growth, development and

compositional changes including development of aroma volatiles has been studied by many researchers. The different storage techniques like low temperature storage, control atmosphere storage, modified atmosphere storage and post-harvest treatments have been studied and recommendations are available for different cultivars to extend the storage life.

14 [h042 / b005](#)

Title The effects of modified atmosphere packaging on quality of loquat fruits

Author E. Çandır, A.A. Polat, A.E. Özdemir, O. Caliskan and F. Temizyürek

Citation ISHS Acta Horticulturae 884:363-367.2011.

Keywords PVC film; 'Gold Nugget'; 'Sayda'; loquat; storage life

Abstract

Loquat fruits cultivars 'Gold Nugget' and 'Sayda' were over-wrapped with 12.5 μ -, 14 μ -, or 16 μ -thick PVC films and kept at 0°C for 60 days. Percent weight loss, skin color (L^* , hue angle), firmness (N), total soluble solids (%TSS), titratable acidity (%TA), physiological and fungal disorders were determined immediately after harvest and at 15-day intervals. Over-wrapping with 12.5 μ -thick PVC film resulted in higher weight loss in both cultivars. Incidence of skin browning was higher in fruits over-wrapped with 16 μ -thick PVC films. Skin browning and decay and off-flavor limited storage life. Storage life of 'Gold Nugget' and 'Sayda' loquat fruits over-wrapped with PVC films could be stored for 30 days at 0°C .

15 [h033 / b005](#)

Title Effect of different packaging materials on storability of fig 'Poona fig'

Author A.R. Kurubar, T.B. Alloli and P.R. Dharmatti

Citation ISHS Acta Horticulturae 890:445-447.2011.

Keywords fig; organoleptic values; packaging materials; physiological loss in weight; storability

Abstract

Fig fruits 'Poona Fig' at full ripe stage harvested from a five-year-old plant and packed in different packaging materials under study were stored at room temperature at (24 to 28°C) with different packages. It was found that the physiological loss in weight (PLW) and rotting percentage of fruits

increased with increase in storage period regardless of packaging material. However, minimum PLW and decay loss was observed under CFB boxes with paper shreddings as cushioning material. The fruits could be stored up to 4 days when packed in CFB boxes with paper shreddings followed by CFB boxes with newspaper as compared to fruits packed in conventional package bag (2 days). The sensory evaluation indicated superiority of CFB boxes with paper shreddings as cushioning material over other packages.

16

[h038/b007](#)

Title Exportability of pomegranate on a threshold in north Karnataka

Author R.M. Hosamani, H. Virupaksha Prabhu, S.B. Hosamani, N.R. Mamle Desai, R.A. Yaledahalli, G.M. Hiremath and B.S. Kulkarni

Citation ISHS Acta Horticulturae 890:629-636.2011.

Keywords *Punica granatum*; bacterial blight; wilt; fruit damage; Koppal

Abstract

Pomegranate (*Punica granatum* L.), an important fruit crop in north Karnataka is commercially grown mainly in the districts of Koppal, Bagalkot, Bijapur, Raichur, Bellary, Belgaum, etc. A survey was done on pomegranate cultivation and marketing. Farmers have benefited economically with its profitable cultivation. The dry weather has greatly facilitated its cultivation with the ingenuity of local innovative farmers and technical support of the research institutions. The fruits are harvested to be marketed in international, national and local domestic markets due to their superior quality. Competitive purchasing through contract farming in some cases and others through the open negotiations with the buyers has ensured increased incomes as there exists a growing demand creating a larger market for the good quality fruits. The cultivars grown are 'Arakta', 'Bhagwa', 'Ganesh', 'Jyoti', etc. A package of practices and quality standards are standardized for different markets. Farmers are mainly facing threat to their orchards by the bacterial blight disease which is nearly wiping out orchards on a devastating scale of late. Earlier the problem of shot hole borer was a big menace. Farmers are striving to stay afloat with these killer problems threatening their livelihood on individual basis. The exportability could be enhanced with the precision management of this disease to ensure quality marketable fruits that are eagerly accepted by the conscious consumers abroad and domestically. The planned setting up of the Agri-Business and Export Knowledge Centre at the University of Agricultural Sciences, Dharwad with local farmer cooperative bodies aims to establish precooling, packaging and cold storage units at Kushtagi, Bagalkot would greatly give boost and strengthen export of pomegranate with greater returns to producers through reduced

middlemen involvement, decreased post-harvest losses, better transportability of fruits in acceptable fresh form to the consumers.

17 [h020 / b001](#)

Title Maturity indices for harvesting of low chilling peach cultivars under mid-hill conditions of Meghalaya

Author K. Dhinesh Babu, R.K. Patel, B.C. Deka and K.M. Bujarbaruah

Citation ISHS Acta Horticulturae 890:449-455.2011.

Keywords harvesting; low chilling cultivars; maturity indices; peach (*Prunus persica*)

Abstract

Peach (*Prunus persica* (L.) Batsch.) is an important fruit crop of temperate regions of the world. The evolving of low chilling cultivars paved the way for peach to sprawl in subtropics also. As they are precocious in nature, they attain maturity earlier. 'TA-170', 'Flordasun' and 'Shan-e-Punjab' are the most important low chilling peach cultivars suitable for growing on commercial scale and grove establishment under mid-hill altitudes of north eastern India. Because of its non-climacteric nature, fruits once picked do not improve in quality. Therefore, it becomes inevitable to fix the maturity indices for harvesting of peach for different stages of maturity viz., hard, firm, firm-ripe, tree-ripe and soft ripe. Hence, experiments were instigated to investigate maturity indices from the orchards grown at 1000 m above mean sea level. The fruit samples were drawn uniformly at weekly interval during different stages of fruit growth and development from 7 weeks after fruit set (immature green stage) to 13 weeks after set (soft-ripe stage). The outcome of the study unveiled the fact that 'TA-170' was earlier to mature and it attained maturity within 11 weeks after fruit set. This was followed by 'Flordasun' and 'Shan-e-Punjab' which attained maturity within 12 weeks after fruit set. The fruits analyzed on 11 weeks after fruit set revealed the best result for 'TA-170' with respect to fruit weight (37.20 g), fruit volume (41.20 ml), specific gravity (0.90), total soluble solids (11.90°Brix), TSS:acid ratio (16.96), vitamin-C (230.67 mg/100 g). For 'Flordasun' and 'Shan-e-Punjab', the fruits harvested on 12 weeks after fruit set secured the good score. Hence, it is advisable to harvest the fruits of peach cultivar 'TA-170' at 11 weeks after fruit set whereas 'Flordasun' and 'Shan-e-Punjab' at 12 weeks after fruit set under mid-hill altitude of Meghalaya.

18 [h038 / b006](#)

Title Studies on extension of postharvest life of pomegranate fruits 'Bhagawa'

Author D.P. Waskar
Citation ISHS Acta Horticulturae 890:455-459.2011.
Keywords physiological loss in weight; quality; shelf life; sugars; wax

Abstract

Freshly harvested pomegranate fruits cultivar 'Bhagawa' were subjected to postharvest treatments of wax, wax coupled with Carbendazim (0.1%). The treated fruits and along with control (untreated) were stored at room temperature (22.17 to 24.36°C and 52.00 to 82.00% RH) and in cool storage (8°C and 90-95 % RH). The results indicated that fruits treated with wax coupled with Carbendazim (0.1%) could be stored up to 65 days in cool storage as against 30 days at room temperature. The data on shelf life, physiological loss in weight (PLW) juice content, acidity, TSS, sugars and organoleptic score indicated that the cool storage is an ideal storage for maintaining proper quality and market acceptability of pomegranate when given a combination of post harvest application of wax and fungicides.

19 [h002 / b007](#)

Title Evolution of the brazilian papaya market
Author O.K. Yamanishi and V.J. Zuffo
Citation ISHS Acta Horticulturae 894:265-272.2011.
Keywords *Carica papaya* L.; Formosa papaya; Hawaii papaya; papaya prices; papaya exports; papaya market; economy; exchange rate

Abstract

This study aims to assess, quantify and analyze various aspects of the papaya crop in Brazil, such as the development of the harvested area and production, crop financial returns to growers, nominal and real prices, price volatility, competition with other imported fruit and aspects of exportation such as quantity, price and destination.

20 [h050 / b006](#)

Title Influence of induced ripening and cold storage protocols on the incidence of postharvest diseases of date palm fruit
Author L. Palou, M.A. del Río, A. Guardado and J. Vilella-Esplá

Citation ISHS Acta Horticulturae 894:235-241.2011.

Keywords *Phoenix dactylifera*; cold storage; decay; CO₂; heat; *Penicillium* spp.

Abstract

Date palm (*Phoenix dactylifera* L.) is a crop of increasing importance in the Elx area (Southeast of Spain). Since in this area date fruit are commercialized for fresh consumption, the most important problems limiting their storability are irregular ripening, weight loss, and postharvest decay. Postharvest treatments to uniformly accelerate fruit ripening and avoid more than one harvest are economically mandatory for the most important date cultivars in the area. In this work, the incidence of major postharvest diseases was determined for two consecutive seasons on locally grown 'Hayani' and 'Medjool' dates sealed in multi-layer PE bags and cold-stored (CS) at -3°C for up to 3 months before or after exposure of non-bagged fruit to induced ripening treatments of 98% CO₂ at 25°C for 2 or 4 days (CO₂) or air at 25°C for 2 or 4 days (Heat). Determinations were performed after shelf-life of 10 days in an ambient air atmosphere at 20°C. Fungal pathogenic isolates were plated in PDA Petri dishes and incubated at 25°C for further macroscopic and/or microscopic identification. Irrespective of the protocol, all 'Hayani' dates exposed to CS, CO₂+CS, and Heat+CS were infected by *Penicillium* spp. Although with variable incidence depending on the season, other frequent disease causal agents were *Aspergillus niger*, *Alternaria* spp., and *Cladosporium* spp., generally in this order. *A. niger* and *Alternaria* spp. were significantly less frequent on Heat+CS and CO₂+CS-treated dates, respectively. On 'Medjool' dates, *Penicillium* spp. and *A. niger* were isolated from about 100 and 10%, respectively, of fruit treated with either CS+CO₂ or CO₂+CS. Severe microbial fermentation was observed on dates exposed to the sequence CS+Heat.

21 [h001 / b007](#)

Title A whole of supply chain approach to developing a new market for Pakistan mangoes: the case of china

Author X. Sun, R. Collins, A. Dunne, B. Bajwa, S. Mazhar and M. Iqbal

Citation ISHS Acta Horticulturae 895:277-282.2011.

Keywords supply chain management; China; Pakistan; mango; quality

Abstract

The 2006 Free Trade Agreement between Pakistan and China, which in principle opened the Chinese market to Pakistan mangoes, could be significant to the Pakistan mango industry, given that China is the largest fruit consuming country in the world and Pakistan is among the world's top mango producers. It could increase Pakistan mango export volumes while at the same time expose Chinese consumers to new mango cultivars. This paper reports on research into the development of the Chinese market for Pakistan mangoes that has been carried out since 2006 under the Australia-Pakistan Agricultural Sector Linkages Program. This research has involved consumer surveys and sensory evaluations, trial shipments and pilot scale supply chain development. Results indicate that Pakistan mangoes have potential in the Chinese market. They are particularly attractive to Chinese consumers because of their sweetness. However, the development of this market will require commitment and cooperation from firms along the whole chain i.e., farmers, contractors, exporters, importers, wholesalers and retailers. This has yet to be achieved.

22

[h001 / b007](#)

Title Developing a fresh mango export value chain with West-African smallholder mango farmers

Author J.W.H. van der Waal and A. Zongo

Citation ISHS Acta Horticulturae 895:283-291.2011.

Keywords farmers' organization; cooperatives; export; organizational model; fair-trade; middle man; trader

Abstract

Many small farmers with mixed farming systems in the West African countries of Burkina Faso, Mali and Côte d'Ivoire, have small mango (*Mangifera indica*) orchards. Starting initially with air cargo shipments, the development of reefer logistics in West Africa enabled the development of a fresh mango export industry. However, smallholder mango farmers in the more remote areas have benefited only marginally. On the initiative of a development organization, a farmers' union was established, aimed at directly exporting Fairtrade certified mangoes, bypassing existing traders and exporters. The trial was not successful as the right contractual agreements between farmers as principals and farmer union staff as agents were not present, leading to uneconomic behaviour by the agents. It became clear that traders and the way their contracts were arranged, played an essential role in quality control, organization of harvesters, transport and risk management, as well as the provision of credit. Based on this experience, an

export company was established, working in close cooperation with farmers' groups, with access to its own packing house and able to contract efficient refrigerated logistics services. By involving the value chain actors in a triangular organization model including farmers, harvesting traders and exporters, it was possible to build on the strong points of each actor and to make the value chain more profitable and attractive for all actors. Moreover, the triangular organization was conducive in obtaining GlobalGAP, organic and Fairtrade certification. The experience with the triangular export organisation demonstrates some important lessons for the development of value chains in the transitional economies. It is important to study the way in which contractual relationships between value chain actors are regulated and to plan interventions with appropriate incentives stimulating behaviour that profits all actors.

23 [f999 / b007](#)

Title Exploring the institutional market for fresh vegetables in the Southern Philippines
Author P.J. Batt, S.B. Concepcion, M.T. Lopez, J.T. Axalan, L.A.T. Hualda and M.O. Montiflor
Citation ISHS Acta Horticulturae 895:59-68.2011.
Keywords institutional markets; fresh produce; quality standards; buyers; suppliers

Abstract

Given the many different ways the product may be used, the institutional market for fresh vegetables in the Southern Philippines can be segmented on the basis of the role market intermediaries perform in the supply chain, where they are, what customers they serve, the range of products required, the volume of product required and the quality specifications. Potential market opportunities are identified and the various constraints smallholder farmers face in endeavouring to meet the needs of institutional buyers are highlighted.

24 [h001 / b007](#)

Title Integrating postharvest, marketing and supply chain systems for sustainable industry development: the Pakistan mango industry as work-in-progress
Author R. Collins and M. Iqbal
Citation ISHS Acta Horticulturae 895:91-97.2011.
Keywords postharvest systems; project model; capacity building

Abstract

Although the Pakistan mango industry is large, its productivity is low, its systems are underdeveloped and wasteful, its farmers are poor and its international reputation is weak. In spite of these shortcomings, its main varieties have consumer potential because they are smooth textured, sweet and aromatic. Capitalising on these positive attributes could provide a means to sustainable industry improvement. A joint Australia-Pakistan research project to address mango industry improvement began in 2006 and has received funding approval to continue until 2014. This paper presents the conceptual model on which the project is based, the main areas of activity that have been pursued over the last three harvest seasons, the results, both positive and negative, and modifications that may be needed in future. The model is based around the aim of delivering a better quality Pakistan mango to the consumer. To achieve this aim, the project adopts a three pillar strategy focused on: (1) improving fruit quality; (2) improving market knowledge; and (3) building better supply chains. Each of these three pillars is supported by capacity building activities. Execution of the model is based on the principle that there should be no barriers between postharvest science and technology, market research and development, supply chain management, and capacity building. Results to date include the uptake of fruit quality improvement practices by significant growers in the industry, a small but encouraging impact on market performance domestically and in export markets, five demonstration chains whose members have implemented the project's 'best practice' recommendations. Capacity building activities have provided hands-on training for scores of market agents, wholesalers, exporters and retailers, and many hundreds of farmers and contractors.

25 [h001; h002; h004; h010; h012; h061 / b007](#)

Title Supply chains and chain coordination mechanisms for fresh fruits: a case study of Mumbai city, India

Author V. Goel

Citation ISHS Acta Horticulturae 895:121-128.2011.

Keywords distribution; institutions; market integration

Abstract

This study was carried out for six selected fruits to identify the supply chains that emerge from the Mumbai wholesale market, chain partners' concerns, how they coordinate and what they gain from it. The study revealed that the wholesale fruit market in the city constitutes a strategic link between the

upstream and downstream chain partners in fresh fruit distribution. Fresh fruit flows from the farm to the wholesale market through several different market players that are product and area specific. Fruit suppliers from different regions and imports prolong the seasonality for apples and grapes; bananas, sweet lime and papayas are available throughout the year; while mangoes are primarily available during the post-harvest period. For the local distribution of selected fruit, three downstream supply chains emerge: retail (the majority), food service and processing. Market agents at each level in the supply chains have forged alliances with their upstream and downstream chain partners to cope with market imperfections and transactions under uncertainty because of the perishable product nature. Vertical coordination for the organized sub segment (food service) is based upon contractual arrangements, whereas for the unorganized segments of food service (retail and processing), it is based upon verbal and mutually understood arrangements. The major thrust of the chain partners at each level of the supply chain is to maintain a regular flow of the products they handle at competitive prices.

26 [f999; h999 / b007](#)

Title The role of wholesale markets in the supply chain for fresh fruit and vegetables in Turkey
Author C. Sayin, B. Ozkan and R.F. Ceylan
Citation ISHS Acta Horticulturae 895:263-268.2011.
Keywords supply chain management; distribution; domestic market; wholesale market; producer unions; European Union

Abstract

Turkey produces around 4% of the world's fresh fruit and vegetables. In the distribution of fresh produce in the domestic market, the wholesale market system dominates. The distribution of fresh fruit and vegetables, other than organic products, food industry ingredients and export product, is subject to regulation. The Wholesale Market Law requires all fresh fruit and vegetables to both enter and exit a wholesale market before reaching retailers and the final consumer. This paper discusses the operation of the wholesale markets in Turkey and with the help of a SWOT analysis, identifies areas for improvement for the distribution of fresh fruit and vegetables.

27 [g012 / b006](#)

Title Benzyladenine and thidiazuron postharvest treatments for preserving cut lily flowers
Author A. Ferrante, A. Trivellini and G. Serra

Citation ISHS Acta Horticulturae 900:301-307.2011.

Keywords cytokinin; yellowing; postharvest; senescence; storage; TDZ

Abstract

The vase life of cut lilies stored for a long time or transported over long distances, may be reduced. Typical postharvest problems are early tepal wilting and abscission and leaf yellowing. Following harvest, chlorophyll losses are induced by the lack of endogenous cytokinins, which are biosynthesized in roots. As the roots are removed there is no cytokinin supply to the shoot in the postharvest phase. The objective of this work was to evaluate thidiazuron as a potential postharvest treatment for preventing chlorophyll losses during storage and for extending the vase life. Lily flowers were harvested at commercial stage when buds begin to show colour. Thidiazuron 10 µM was compared with benzyladenine 50 or 100 µM; both were applied as pulse or continuous treatments. After storing cut flowers for three weeks at 5°C, flowers were transferred to a postharvest evaluation room under controlled environmental conditions. Vase life, chlorophyll content, weight change and relative water content were monitored. Results showed that thidiazuron-treated stems had higher chlorophyll content compared with the control and benzyladenine treatments. After three weeks of cold storage, the chlorophyll content of thidiazuron-treated flowers was 0.84 mg/g FW which was significantly higher than the content of the control (0.57 mg/g FW). Thidiazuron slowed down the degradation processes and, after storage, the chlorophyll decline was only 25% of the initial value. Weight loss was higher in continuously applied treatments compared with control and pulse treatments. In conclusion, results obtained showed that the best treatment for preserving cut lilies was a pulse treatment for 24 h with 10 µM thidiazuron.

28 [g012 / b000](#)

Title Carbohydrate changes during flower senescence of the Easter lily (*Lilium longiflorum* Thunb.)

Author Jong Suk Lee and M.S. Roh

Citation ISHS Acta Horticulturae 900:295-300.2011.

Keywords cell wall neutral sugars exudates; floral organs; ethanol soluble carbohydrates

Abstract

This research was initiated to examine changes in ethanol soluble carbohydrates and cell wall neutral sugar composition in various floral organs of cut *Lilium longiflorum* Thunb. (Easter lily) flowers.

Fresh weight of anthers decreased sharply, reaching a minimum level 3 days post-anthesis (DPA). Tepals began to lose their firmness 6 DPA, and flowers were considered senesced 11 DPA. The level of soluble sucrose from anthers was the highest 2 to 3 DPA. Conversely, the level of glucose and fructose reached their lowest levels, thus limiting the available carbon sources in anthers after anthesis. Arabinosyl and galactosyl residues were only detected in polysaccharides from exudates produced at the latter stages of flower development. The xylosyl, galactosyl, rhamnosyl, non-cellulosic glucosyl, mannosyl, and arabinosyl contents of cell wall materials decreased by 50% 3 DPA. Galactose and xylose were the major cell wall neutral sugar components, and remained the highest compared to other cell wall sugar residues during the entire period of flower bud senescence. It is possible that a rapid decrease in glucose and fructose could arrest anther development or the maturation of pollen and trigger tepal senescence.

29 [g012 / b006](#)

Title Effect of hot water pretreatment and cool-storage to maintain freshness of 'Aktiva' cut lily

Author Xue Wei Wu, Jeung Keun Suh, Ji Hee Kim and Li Hua Wang

Citation ISHS Acta Horticulturae 900:273-281.2011.

Keywords post-harvest physiology; oriental lily

Abstract

Dipping the cut end of flower stems in hot water has been shown to be effective in increasing postharvest life in various floral crops. The effects of hot water dipping treatment on 'Aktiva' oriental lily were studied. Dipping the cut stem end into 48°C water for 20 min followed by storage at 5°C for 7 days or at 85°C for 20 s plus storage at 5°C for 12 days increased the vase life by 5.9 or 5.8 days, respectively, as compared to the control. Hot water dip and low temperature storage treatments did not negatively affect the quality of cut flowers, but significantly extended longevity of cut 'Aktiva' oriental lily flowers ($P < 0.05$).

30 [g012 / b000](#)

Title Effect of pre-shooting temperature and duration for enhancing cut flower quality of *Lilium* oriental hybrid 'Siberia' in summer season in Korea

Author Jae-Young Ko, Kang-Jun Choi, Dae-Ki Hong, Hee-Sun Noh, Hye Kyung Rhee and Jung-Soo Lee

Citation ISHS Acta Horticulturae 900:309-312.2011.

Keywords *Lilium* oriental hybrid; pre-shooting; cut flower; 'Siberia'; flower bud; highland

Abstract

Summer cut flower production of *Lilium* oriental hybrids has some problems including short stems, reduced number of flower buds, and shortened inflorescence length. The temperature and length of pre-plant holding before planting bulbs were studied in an effort to improve quality of 'Siberia' oriental hybrid lilies. 'Siberia' bulbs were held at 9, 12 or 15°C, for 9, 14, or 19 days before planting (10 June) in Gangneung (a high land, 600 m a.s.l.). When held at 12°C for 14 days before planting, the length and weight of harvested stems increased and physiological flower bud blindness was reduced by 46% as compared with controls. When 'Siberia' was held at 12°C for 17 days before planting at the other high site (Muju, 400 m a.s.l.) on 20 July, stem length and flower bud length were 90.2 and 12.5 cm, greater than the other treatments and bud blindness was reduced by 35.5% as compared with the control.

31 [g012 / b006](#)

Title Effects of STS, akacid and 8-hydroxy-quinoline sulfate on the vase life and colony count of preservative solution in *Lilium candidum*

Author H. Alinejad and E. Hadavi

Citation ISHS Acta Horticulturae 900:289-294.2011.

Keywords cut flower; microorganisms; *Liliaceae*

Abstract

Two levels of pulse treatment (silver thiosulfate, STS, 98.7 mg L⁻¹, equivalent to 0.59 mM L⁻¹ silver and distilled water; each for 6 h) and 9 levels of preservative mixtures (silver nitrate at 25, 50 and 70 mg L⁻¹, equivalent to 0.15, 0.3 and 0.41 mM L⁻¹ silver respectively; 8-hydroxyquinoline sulfate at 150, 300, 450 mg L⁻¹; Akacid with concentrations of 100, 300 and 500 mg L⁻¹) were investigated for their effects on vase life of *Lilium candidum*. The experiment was conducted in a randomized design factorial arrangement (2×9). Silver nitrate in preservative mixtures in applied concentrations yielded the lowest vase life and colony count. Akacid, while proving effective in reducing the bacterial colony count, also increased vase life at 500 mg L⁻¹ without STS pretreatment. 300 mg L⁻¹ 8-HQS caused the highest vase life. A positive and significant correlation between vase life and colony count was seen which raises the possibility that not all bacteria are detrimental to cut flower vase life.

32 [g012 / b000](#)

Title Ethylene and anti-ethylene technologies in lilies

Author P.M. Filios and W.B. Miller

Citation ISHS Acta Horticulturae 900:283-288.2011.

Keywords ethylene; *Lilium*; 1-methylcyclopropene; 1-MCP

Abstract

Ethylene is a gaseous plant hormone that accelerates ripening in many fruits and vegetables, and causes senescence in many ornamentals. Lilies are known to be sensitive to ethylene during plant growth, and previous research has shown that long-term (e.g., many weeks) exposure to as little as 0.05 to 0.1 ppm can lead to stunted plants with no market value. Higher concentrations over shorter periods can also injure growing plants. To better understand ethylene effects in lilies, studies were conducted with two Asiatic hybrid lily cultivars ('Orange Pixie' and 'Pink Pixie') and *L. longiflorum* 'Nellie White'. When hybrid lilies (at visible bud stage or ca. 2 weeks later) were exposed to 0.25 or 0.75 ppm ethylene for 1 to 7 days (20°C, in darkness), no injury occurred with 1 day of exposure, but nearly 100% flower abortion was seen with 4 days exposure. Similar results were seen with 'Nellie White' with 1 ppm ethylene. Injury was highly dependent on bud size, with buds less than ca. 3 cm being susceptible to 1 day of ethylene (Asiatic hybrid cultivars) and less than ca. 4 cm ('Nellie White'). The ethylene perception inhibitor, 1-methylcyclopropene (MCP) was highly effective in protecting plants against ethylene. When applied as a foliar spray, MCP at concentrations of 10-50 mg/L (active ingredient) fully protected plants against a 4-d treatment with exogenous ethylene. Initial results using ethephon (an ethylene releasing chemical) as a potential growth regulator for height control in Oriental hybrid lilies are presented.

33 [q014 / b007](#)

Title Market of lily bulbs in Argentina

Author P. Marinangeli, L. Scoponi and N. Curvetto

Citation ISHS Acta Horticulturae 900:37-41.2011.

Keywords *Lilium*; imports; exports; cut flowers; pot plants

Abstract

In Argentina more than 91% of lily bulbs are produced as cut flowers and the rest as pot plants and dry sales. Flower producers import their bulbs or purchase them from retailers, although in this case the prices are often higher. 91% of the bulbs are imported from Europe, mainly The Netherlands, and are usually transported by ship. 9% are obtained from Chile and transported by truck. Argentinean imports of lily bulbs increased significantly until 2001, followed by a drastic decrease due to the deep devaluation of the Argentinean currency in 2002. This resulted in increased costs of crop production and depressed the demand. However, imports rose again starting from 2005 up to 2009, reaching 6.3 million bulbs. This surpassed the value of bulbs imported in 2001. Although the quantity of imported bulbs increased, the number of importers decreased from 9 in 2001 to 4 in 2008, showing a concentration of the market. In 1999 Asiatic and Oriental hybrids were widely cultivated with a smaller proportion of *L. longiflorum* × Asiatic (LA) hybrids and *L. longiflorum* cultivars. At the present time, LA, Oriental × Trumpet (OT) and Oriental hybrids are the top choices, followed in a smaller proportion by the Asiatic, *L. longiflorum* × Oriental (LO) and *L. longiflorum* hybrids. The market of lily cut flowers and pot plants in Argentina is expanding, and bulb imports and local production are expected to increase. A comparison with the lily market in the neighboring countries is presented.

34

[g012 / b000](#)

Title The postharvest quality of cut lily flowers and potted lily plants

Author W.G. van Doorn

Citation ISHS Acta Horticulturae 900:255-264.2011.

Keywords carbohydrates; cut flower; inflorescence; hormones; storage; shelf life; storage; pot plant; vase life; water relations

Abstract

As in other flowers, the vase life of cut lily flowers depends on the cultivar, cultivation, the conditions during storage and transport, and those of vase life. This review focuses on the physiological reasons for the end of vase life. These reasons can be grouped according to three categories: imbalance in hormone levels, inadequate carbohydrates, and adverse water relations. Before discussing these backgrounds I will examine the symptoms that limit the vase life of many lily flowers. Lily hybrids are categorised into several groups. The main groups for cut flower production are Asiatic hybrids, Oriental hybrids, *Lilium longiflorum* hybrids (also called *Longiflorum*) and LA-hybrids (due to their *Longiflorum* and Asiatic background). Flowers with two whorls of coloured floral leaves have no sepals, and all floral

“leaves” are called tepals. The inner whorl, consisting of three tepals, is homologous to the petals in flowers with separate petals and sepals. The outer whorl, also consisting of three tepals, is homologous to the sepals in flowers with separate petals and sepals. This review will focus on cut inflorescences, but for comparison several data from potted plants will also be discussed.

35 [h017 / b006](#)

Title Browning of minimally processed pineapple treated with citric acid
Author R. Nur Azlin, M.N. Latifah, M.T. Mohd Kamal, M. Habsah and R. Muhd Amin
Citation ISHS Acta Horticulturae 902:499-503.2011.
Keywords fresh cut pineapple; enzymatic browning; polyphenol oxidase; antibrowning

Abstract

This study was conducted to investigate the effect of citric acid treatments on the browning of minimally processed (MP) pineapple stored at 10 and 2°C for 7 and 14 days, respectively. The MP pineapples cut in longitudinal shapes (5 cm) were treated with citric acid concentrations of 1% (T1), 1.5% (T2) and 2% (T3). An untreated sample was used as the control (T0). Samples were evaluated for colour (L*, a*, b* and hue), pH and total titratable acidity (TTA). The activity of polyphenol oxidase (PPO) was monitored to assess its relationship with surface browning of MP pineapple. There were no significant differences in the hue values of the treated and control samples till the end of the storage period both at 10 and 2°C. Lowered pH values were observed for all treated samples both at 10 and 2°C, as compared to the control samples. Fresh-cut pineapple treated with 1.5 and 2% citric acid had significantly ($p < 0.05$) higher TTA than did the 1% citric acid treatment and the control for storage at both 10 and 2°C. The activity of PPO of the samples treated with 1 and 1.5% citric acid was lower than the control for the sample stored at 10°C. However, inconsistent trends were shown in the activity of PPO throughout the 14 days storage at 2°C.

36 [h017 / b000](#)

Title Changes and distribution of aroma volatile compounds from pineapple fruit during postharvest storage
Author C.B. Wei, S.H. Liu, Y.G. Liu, X.P. Zang, L.L. Lu and G.M. Sun
Citation ISHS Acta Horticulturae 902:431-436.2011.
Keywords pulp; core; solid-phase microextraction; GC/MS; color; firmness; total soluble solids

Abstract

The aroma volatile compounds in both pulp and core of ‘Tainong 17’ pineapple fruit were extracted by head-space solid-phase microextraction (HS-SPME) and analyzed by gas chromatograph-mass spectrophotometer (GC-MS) during postharvest storage (at the 1st, 6th and 9th day after harvest) at 25±1°C. Eighteen volatile compounds were identified, in which, esters were the most dominant, and butanoic acid methyl ester, hexanoic acid methyl ester and 3-(methylthio) propanoic acid methyl ester were all detected in both pulp and core. During the postharvest storage, the total content of esters increased from 65.47 to 81.18% in the pulp, but increased at the beginning and then decreased later in the core. At the 1st day, the content of hexanoic acid methyl ester was highest of all compounds in the pulp and the core, followed by butanoic acid methyl ester in the pulp. At the 6th day, butanoic acid methyl ester was the most dominant in the pulp followed by hexanoic acid methyl ester and octanoic acid methyl ester, while hexanoic acid methyl ester was the highest in the core followed by octanoic acid methyl ester and butanoic acid methyl ester. At the 9th day, hexanoic acid methyl ester and methyl-2-methylbutyrate were the main aroma compounds in the pulp, while butanoic acid methyl ester and hexanoic acid methyl ester were the main compounds in the core. At day 9, the contents of esters increased to the maximum in the pulp (81.18%) while they reached a minimum in the core (47.13%). Esters are an important class of volatile aroma compounds in not only the pulp but also the core.

37

[h017 / b000](#)

Title Development of a slicing machine for fresh-cut pineapple
Author I. Ab Aziz, A. Samsudin, A. Shafie, M.N. Latifah and O. Azlan
Citation ISHS Acta Horticulturae 902:477-478.2011.
Keywords I. Ab Aziz; A. Samsudin; A. Shafie; M.N. Latifah; O. Azlan

Abstract

Preparation of fresh-cut pineapple usually is done manually to form cubes, semi-circles or wedges. The cut product is not uniform, which causes problems during packing. Preparation is also time consuming, especially for the bulk handling of fresh-cut pineapple for commercial application. Imported machines for cutting fruits into various shapes are available on the market. However, the high cost of the machine hinders use, especially by small-scale fruit operators. Intensive research had been conducted in developing a suitable slicing machine to cater for the needs of the local pineapple processors. The

development of the slicing machine was based on two systems, namely rotary and centrifugal type working condition. This paper emphasizes machine development and its operating system. At normal rate, the slicing machine is capable of processing 360 fruits per hour. The slicing machine is easy to operate, of simple design, cost effective and easy to clean.

38 [h017 / b006](#)

Title Effect of alginate and gellan-based edible coatings on the quality of fresh-cut pineapple during cold storage

Author N. Azarakhsh, A. Osman, H.M. Ghazali, C.P. Tan and N. Mohd Adzahan

Citation ISHS Acta Horticulturae 902:519-524.2011.

Keywords 'Josapine' pineapple; fresh-cut; edible coating; sodium alginate; gellan gum

Abstract

Pineapple is one of the most popular fruits in Malaysia and consumer demand for fresh-cut pineapple is increasing in world markets. However, its shelf life is limited. The aim of this work was to study the effect of alginate and gellan-based edible coatings on changes in colour, weight loss, firmness and respiration rate of fresh-cut 'Josapine' pineapple during 16 days storage at $10\pm 1^{\circ}\text{C}$; $65\pm 10\%$ RH. Uncoated fresh-cut pineapple at the same condition served as control. The results showed that for colour, the L^* (lightness) and chroma decreased over time in all treatments. However, L^* and chroma in coated samples were significantly ($p < 0.05$) higher than the control. The hue angle of control samples was significantly ($p < 0.05$) lower than coated samples. Weight loss increased over time during storage. After 16 days, the weight loss of control was $22.4\pm 0.9\%$, but the weight loss of both alginate and gellan coated samples were significantly lower than control ($15.4\pm 0.8\%$ and $16.5\pm 0.6\%$ respectively). Respiration rate of fresh-cut pineapples with alginate or gellan coating was significantly ($p < 0.05$) lower than control during storage. Firmness of coated samples during storage was not significantly different with the fresh sample. However, the firmness of control after 16 days was significantly ($p < 0.05$) lower than fresh sample (1.39 ± 0.19 N and 2.54 ± 0.28 N respectively). The results obtained in this study indicate that alginate and gellan-based edible coatings could significantly reduce weight loss and respiration rate and maintain the colour and firmness of fresh-cut pineapple during low temperature storage as compared with the control (uncoated sample).

39 [h017 / b006](#)

Title Effect of citric acid treatment on the quality of fresh-cut pineapple
Author M.N. Latifah, O. Zaulia, M.P. Nur Aida, O. Fauziah, M. Hairiyah and Y. Talib
Citation ISHS Acta Horticulturae 902:467-476.2011.
Keywords fresh-cut; citric acid; flesh firmness; microbial counts; quality

Abstract

The effect of citric acid treatment on the quality of fresh-cut pineapple was evaluated during storage at 10 and 2°C. The fresh-cut pineapple was mechanically sliced into small portions (5 cm) and immersed in solutions containing 0 (control), 1.0, 1.5 and 2.0% citric acid. Samples stored at 10°C were evaluated every 2 days whereas those samples stored at 2°C were evaluated every 4 days. No significant difference was observed in the change in colour of the fresh-cut pineapple stored at 10°C for 6 days and at 2°C for 14 days. Loss in fresh weight was somewhat more rapid at 10 than at 2°C and increased over time in all treatments stored at the two temperatures. Variation in firmness was small throughout the storage period at both temperatures and there was no consistent change over time. Microbial growth over time did not change for samples stored at 2 °C, but increased steadily in those stored at 10°C. Fresh-cut pineapple treated with 1.5% citric acid was more accepted by the panelists, possibly due to the combined effect of the pH and TSS value as indicated in the taste preference.

40 [h017 / b006](#)

Title Effect of hydrogen peroxide on quality of fresh-cut pineapple stored at 5°C
Author M.P. Nur Aida, M. Hairiyah, W.H. Wan Mohd Reza and M. Nur Ilida
Citation ISHS Acta Horticulturae 902:493-498.2011.
Keywords hydrogen peroxide; fresh-cut; 'Josapine'; sanitizing; storage; quality

Abstract

The effect of hydrogen peroxide (H₂O₂) as a sanitizing treatment on fresh-cut pineapple stored at 5°C was investigated. Fruits were pre-cooled overnight at 10°C prior to cutting. Treated and untreated (control) cut-fruits were immersed in 1 or 3% H₂O₂, packed in rigid polypropylene containers and stored at 5°C for 10 days. Analyses of colour, firmness, pH, total soluble solids (TSS), ascorbic acid and total acidity were done at 3-4 day intervals. Sensory evaluation and microbiological analysis were also monitored during the storage period. Fresh-cut pineapple treated with 3% H₂O₂ maintained flesh firmness

better than 1% H₂O₂ and had the highest lightness value. No significant differences in microbial counts, physiochemical values and sensory attributes were observed between samples left untreated or treated with 1 or 3% of H₂O₂.

41 [h017 / b006](#)

Title Effect of methyl bromide fumigation on quality of 'Josapine' and 'n36' pineapples
Author M. Pauziah, H. Abdullah, M.S. Mohammed, O. Mohd Shamsuddin, M. Norhayati and S. Ahmad Tarmizi
Citation ISHS Acta Horticulturae 902:437-441.2011.
Keywords white patch; phytosanitary; browning, quality; quarantine treatment

Abstract

The quarantine procedures in some countries, including China, Australia and Iran, require Malaysian pineapples to be imported into those countries to be fumigated with 32 g/m₃ methyl bromide for a minimum of 2 hours to control pests prior to shipment. The effects of methyl bromide fumigation on the fruits of 'Josapine' and 'N35' were studied. Fruits of the two cultivars were harvested at breaker colour (colour index 2) and the fruits were packed in corrugated fibreboard boxes. The fruits were then fumigated with methyl bromide at concentrations of 24, 28 or 32 g/m₃ for 2 hours. Non-fumigated fruits were used as the control. All the fruits were stored at 10°C. After 10 days, the fruits were removed from storage and held at room temperature (25°C) for 7 days. Fumigation with 24, 28 or 32 g/m₃ of methyl bromide for 2 hours reduced the quality of both pineapple cultivars.

42 [h017 / b007](#)

Title Effect of oxygen scavenger application on the quality of fresh-cut pineapple
Author M.N. Latifah, I. Ab Aziz, O. Zaulia, O. Fauziah and Y. Talib
Citation ISHS Acta Horticulturae 902:459-466.2011.
Keywords fresh-cut; oxygen scavenger; quality; shelf life

Abstract

The effect of an oxygen scavenger on the quality of the fresh-cut 'Josapine' pineapple was investigated during storage at 10 and 2°C. Rigid polypropylene containers (10×10 cm) with a clip-on lid

over-wrapped with stretch film were used for packing the fresh-cut pineapple. Containers with a sachet of oxygen scavenger (FX- 2 g) inserted were compared with similarly packaged samples without the sachet. Weight loss, flesh firmness, surface colour (lightness and hue value), total soluble solids (TSS), pH, gases in package (O₂, CO₂ and ethylene), and sensory evaluation were determined every 2 days for 8 days for samples stored at 10°C and weekly for 15 days for samples stored at 2°C. No significant changes in surface colour (b value), flesh firmness, TSS or pH were observed between treated and untreated samples throughout the storage period for samples stored at 10 or at 2°C. Weight loss increased with storage time for both samples, losses were greater for the control than for treated samples, the rate of loss up to the 9th day was the same at both temperatures and losses continued until the experiment was terminated on day 15. The number of colony forming units (cfu) of both control and treated samples increased significantly between day 6 and day 8 for samples stored at 10°C. The number of cfu remained almost constant in samples stored at 2°C throughout the 15-day storage period.

43

[h017 / b003](#)

Title Effect of ozonated water wash on quality of fresh-cut 'Josapine' pineapple during storage
Author M.P. Nur Aida, M. Hairiyah, W.H. Wan Mohd Reza and M. Nur Ilida
Citation ISHS Acta Horticulturae 902:487-492.2011.
Keywords ozone; fresh-cut; storage; microbial

Abstract

Chlorine is prohibited in organic food production while aqueous ozone is approved for such use in the United States. Ozonated water leaves no residue on products and could replace chlorine as a sanitizer. The effects of an aqueous ozone wash on the quality of fresh-cut 'Josapine' pineapple was investigated in this study. Fruits were pre-cooled overnight at 10 prior to cutting. Cut pineapple samples were washed with ozone water concentrations of 0.6, 0.9 and 1.5 ppm with a water wash as the control. A corona-discharge ozone generator was used to produce the ozone. Fresh cut fruit samples weighing 220 g were packed in rigid polypropylene containers and stored for 20 days at 2°C. The pH values of the ozone-treated samples were slightly but significantly higher than in control samples and also increased significantly over time in all samples. The quality parameters total soluble solids, ascorbic acid and total titratable acidity, colour attributes (L^* , a^* , b^* , hue and chroma), texture, total plate count, total coliform and total yeast and moulds were not significantly different from those in the control samples. The

microbial population was reduced as the ozone concentration increased. Further research is needed to evaluate the effect of ozone on the quality of fresh-cut pineapple.

44 [h017 / b006](#)

Title Effect of storage duration on the quality of fresh-cut 'Josapine' pineapple
Author Y. Nor Hanis Aifaa, O. Zaulia, M.P. Nur Aida, M. Habsah, M.N. Azhar and M.Z. Zaipun
Citation ISHS Acta Horticulturae 902:479-486.2011.
Keywords quality; before fresh-cut; pineapple; different storage

Abstract

The rationale of this study was to observe the quality acceptance of 'Josapine' pineapple fruit exported by sea shipment which later will be marketed as fresh-cut fruit. The temperatures, 10 and 2°C, used in this study represent the actual storage temperature of ship containers and retail market refrigeration systems, respectively. Firmness of the flesh was slightly decreased during storage at 10°C and after minimal processing and storage at 2°C. The pH value of fresh-cut fruit was higher, whilst the titratable acidity (TTA) decreased with duration of storage. The TSS value was maintained during storage at both at 10 and 2°C. For fruit previously stored at 10°C for 2 weeks, blackheart symptoms were slightly visible in fresh-cut pineapple after 2 weeks storage at 2°C. Blackheart symptoms were visible in fruits previously stored for 3 weeks at 10°C. Symptoms of blackheart were also observed in fresh-cut pineapple after 1 week storage at 2°C. Higher standard plate count (SPC) was observed with prolonged storage of whole pineapple fruits at 10°C. However, the coliforms count was undetectable after 3 weeks removal from 10°C.

45 [h017 / b006](#)

Title Effect of storage time on physical, chemical properties and sensory attributes of 'Queen' pineapple fruit
Author C.N. Linh, J. Adisak
Citation ISHS Acta Horticulturae 902:427-430.2011.
Keywords storage time; morphology; physical; chemical property; sensory; pineapple (*Ananas comosus* 'Phulae')

Abstract

'Queen' pineapple (*Ananas comosus*, 'Phulae' clone) fruits were stored at 25°C, RH of 80-85% and physical (flesh color; lightness (L*), red-green (a*) and yellow-blue (b*) values), chemical (total soluble solids (TSS), titratable acidity (TA), and, pH), and sensory properties were evaluated. Flesh color (L*, a*, b* values), TA (citric acid), and sensory score decreased with the storage time. On the other hand, the TSS value increased, while there were only slight changes in pH value during the 10-day storage time.

46 [h017 / b007](#)

Title Fresh pineapple market: from the banal to the vulgar
Author D. Loeillet, C. Dawson and T. Paqui
Citation ISHS Acta Horticulturae 902:587-594.2011.
Keywords pineapple; fresh fruit; world market; innovation; import price; consumption

Abstract

The fresh pineapple international market has grown in a very impressive way in the last 10 years. This success story has been mainly lead by innovation and good management of the distribution chain. However, since 2008, this trend is changing and the growth is nowadays starting to slow down, even decrease. The reasons for this new trend, besides climatic reasons or even economic recession in importing countries, are mostly related to the import price crisis. Fresh pineapple, due to its democratisation, is becoming cheaper as volumes increase, as sources diversify creating heterogeneous quality and as the fruit becomes ordinary and mass consumption.

47 [h017 / b005; b006](#)

Title Handling of fresh-cut pineapple for fresh consumption
Author M.N. Latifah, H. Abdullah, O. Fauziah, Y. Talib, I. Ab Aziz and M.S. Faridah
Citation ISHS Acta Horticulturae 902:409-414.2011.
Keywords fresh-cut; handling operations; packing; storage

Abstract

Pineapple is one of the popular fruits served in fresh-cut form. At ambient temperature and without protective treatments, cut pineapple turns slimy and deteriorates rapidly, resulting in the

development of off flavours and odours within a day. Fresh-cut pineapple sustains substantial tissue injury during processing; the disruption of tissue and cell integrity often increases respiration rate, ethylene synthesis, enzymatic browning and the development of physiological disorders with associated increases in rates of other biochemical reactions responsible for changes in colour (including browning), flavor, texture and nutritional quality (sugar, acid and vitamin contents). The damaged plant tissues also provide a nourishing medium for microbial survival and growth. Chemical treatments with sodium chloride, calcium chloride and ascorbic acid can improve the taste, flesh firmness and overcome the browning problem in cut pineapple of 'Josapine'. Rigid polypropylene containers are used for the packing system and an oxygen absorbent is inserted in the package for quality enhancement of the stored product. Fresh-cut pineapple can be stored for two weeks at 2°C, one week at 10°C and two days at 25°C. This paper elaborates the handling operations, packing systems and storage requirements for fresh-cut pineapple. Issues involved in maintaining both quality and safety are also discussed.

48

[h017 / b006](#)

Title Microbiological quality of fresh-cut pineapple with an in-package oxygen absorbent

Author M. Nur Ilida, A.S. Asiah, M.P. Nur Aida and M. Hairiyah

Citation ISHS Acta Horticulturae 902:513-518.2011.

Keywords shelf life; spoilage; bacteria; yeast; mould; storage temperature

Abstract

Fresh-cut pineapple is perishable with a shelf life that is mostly dependent on storage conditions, including oxygen concentration. Oxygen is required for the growth of most spoilage and many pathogenic organisms, including moulds, which shorten the shelf life of the product. Oxygen absorbents remove oxygen from the environment through a chemical or enzymatic reaction and do not require the atmosphere in the package to be altered prior to closure. This study was conducted to determine the effect of an in-package oxygen absorbent on the microbiological quality (total plate count, coliform count, and yeast and mould count) of fresh-cut 'Josapine' pineapple stored at 2 and 10°C. Fresh-cut pieces of fruit were packaged in polypropylene clip-on containers with or without oxygen absorbent, sealed with parafilm and stored at 2°C for up to 15 days or at 10°C for up to 8 days. There was no significant difference ($p>0.05$) in total plate counts of bacteria or yeast and mould counts between treated and control samples stored at either temperature. The coliform count in treated and control samples stored at 2°C were not significantly

different. However, the coliform count was significantly reduced, relative to the control, when an in-package oxygen absorbent was present with fruit stored at 10°C.

49 [h017 / b000](#)

Title Pre- and postharvest metabolism of crown leaves of pineapple fruit
Author E. Londers, J. Ceusters, C. Godts, M.P. De Proft and B. Van De Poel
Citation ISHS Acta Horticulturae 902:233-238.2011.
Keywords cell burst; crassulacean acid metabolism; gas exchange; long term storage; organic acid; transport conditions

Abstract

Crown burn on exported pineapple fruit causes serious economical losses. In this study, crown burn occurrence was hypothesized to be related to Crassulacean Acid Metabolism (CAM). However, the functioning of this metabolism in the crown leaves remained unexplored. Therefore, pre- and postharvest bio-activity of the crown leaves of pineapple fruit were studied. With the fruit still attached to the plant, CAM activity was detected in the crown leaves. While post-transport diurnal light cycle conditions seemed to reactivate CAM in the crown leaves, no CAM activation was registered during cold-storage transport (simulated) under dark conditions. The substantial organic acid increase in the crown leaves during transport is thought to originate from the pineapple fruit itself and seems to be the major cause of leaf browning.

50 [h017 / b006](#)

Title Quality changes of pineapple (*Ananas comosus* 'Josapine') as affected by controlled atmosphere
Author M. Razali, O. Zaulia, M. Habsah, D. Che Omar and M.Z. Zaipun
Citation ISHS Acta Horticulturae 902:443-447.2011.
Keywords storage life; 'Josapine' pineapple; controlled atmosphere; quality changes

Abstract

Pineapple (*Ananas comosus* 'Josapine') fruits were stored in an atmosphere consisting of 3, 5 or 7% O₂ in N₂ or in air (21% O₂; control) with 8% CO₂ for 5 weeks at 10°C. The quality changes were

observed based on colour, total soluble solids (TSS), total titratable acidity (TTA) and total sugar. Results showed that fruits stored in 3-5% O₂ exhibited the greatest suppression in value of chroma and TSS as compared to the others. The hue angle, TTA and total sugar in low-O₂ atmosphere for 5 weeks were significantly ($p<0.05$) higher than air-stored (control) fruit, whilst chroma value and TSS values were lower during storage at 10°C. This study indicates that the quality of 'Josapine' was maintained as a result of storage in 3 and 5% O₂ atmosphere for up to 5 weeks at 10°C.

51

[h017 / b000](#)

Title Quality evaluation for fresh-cut pineapple cut into different shapes
Author M.R. Bizura Hasida, M.N. Latifah, W.H. Wan Reza, M.Z. Zaipun and O. Fauziah
Citation ISHS Acta Horticulturae 902:505-511.2011.
Keywords fresh cut pineapple; longitudinal; semi-circular

Abstract

Quality evaluation for fresh pineapple cut into different shapes was monitored during storage at 2°C. Samples were evaluated on daily basis for physical changes (colour), chemical composition (pH, total titratable acidity (TTA) and °Brix), gases (O₂, CO₂ and C₂H₄) and sensory attributes. The pineapple fruits were manually peeled and cut into longitudinal and semi-circular shapes. The cut pieces were randomly selected for packing in polypropylene containers (10×12 cm) with lid sealed. The results showed that the different shapes did not significantly affect the physical and chemical changes. The gradual loss of lightness (L* value) from 78.86 to 73.12 was noticeable in the cut pieces, which may be directly attributed to the translucency phenomenon in the fruit flesh towards the end of the 9-day storage period. Fruit °Brix increased from 10 to 13 whereas a decreasing trend in the pH and TTA values occurred in both shapes. The headspace composition of the longitudinal cut had a higher percentage of CO₂ and C₂H₄ as compared to the semi-circular cut. However, no significant difference was observed in O₂ composition of the two cut shapes throughout the 9-day storage period. The longitudinal cut was more preferred by the panelists due to the combination of sweet and sour tastes within one piece.

52

[h017 / b000](#)

Title Quality maintenance of pineapple in postharvest handling
Author H. Abdullah
Citation ISHS Acta Horticulturae 902:403-408.2011.

Keywords blackheart; chilling injury; preconditioning; standards; storage

Abstract

The quality of fresh fruits is a combination of characteristics, attributes and properties that give the commodity value for food. Quality is used in various ways to indicate degree of excellence. For pineapple, quality is always associated with excellent appearance, freshness, taste, colour and aroma, besides being free from injuries and disorders. Effective postharvest handling should begin with excellent quality fruits at harvest and continues with proper control measures along the handling chain until consumption. Pineapple for long distance markets should be able to withstand long distance transportation and still remain in excellent condition after reaching the destination. Effective maintenance of quality in pineapple incorporates good handling practices including the use of cold chain, proper grading, suitable packaging and the right treatments.

53 [h017 / b000](#)

Title Relationship between chemical properties and acceptability of 'Smooth Cayenne' pineapple

Author J. Jintana, J. Adisak and W. Chatlada

Citation ISHS Acta Horticulturae 902:453-458.2011.

Keywords chemical factors; acceptability; pineapple; 'Smooth Cayenne'; *Ananas comosus*

Abstract

The objective of this study was to evaluate the relationship between pineapple fruit total soluble solids (TSS), titratable acidity (TA), the ratio TSS/TA, and pH and consumer acceptability of 'Smooth Cayenne' pineapple (*Ananas comosus* (L.) Merr.) fruit by path analysis. Only the ratio TSS/TA directly affected the consumer acceptability score. The path coefficient was 0.239 and was significant at $p \leq 0.05$. TSS, TA and pH indirectly affected acceptability and their path coefficients were, respectively, 0.774, -0.187 and 0.105, which were significant at $p \leq 0.05$.

54 [f999; h999 / b005](#)

Title Biology and management of microbial biofilms on plant surfaces

Author M.W. Harding, M.E. Olson, L.L.R. Marques and R.J. Howard

Citation ISHS Acta Horticulturae 905:43-55.2011.

Keywords post-harvest; MBECTM Assay; BESTTM Assay; biocontrol; IPM

Abstract

Biofilms are communities of microorganisms growing within a self-produced extracellular polymeric matrix, and in association with a surface. Cells within a biofilm frequently have measurable, or observable, phenotypes that are distinct from comparable cells growing in more solitary or free-floating (planktonic) conditions. For example, cells within a biofilm are frequently able to survive antibiotic or biocide treatments that are lethal to comparable planktonic cells. Descriptions of biofilms formed by phytopathogenic bacteria and fungi have confirmed that, in some cases, plant disease management strategies may need to be effective against biofilms. Development of high through-put technologies, such as the MBECTM and BESTTM plate assays for rapid culturing and assessment of microbial biofilms, have greatly accelerated the ability to screen for anti-biofilm compounds and treatments. Furthermore, use of these assays has facilitated characterizations of cell populations and growth stages within biofilm development for single and mixed species biofilms. Technology and information developed through this type of biofilm research has significant potential to support the identification and development of novel, effective biocontrol strategies.

55 [h052 / b000](#)

Title Changes in expression of oxidative stress related genes in grapefruit peel in response to the yeast, *Metschnikowia fructicola*

Author V. Hershkovitz, C. Ben-Dayana, L. Cohen, B. Weiss, G. Raphael, O. Feygenberg, S. Droby, M. Wisniewski and J. Liu

Citation ISHS Acta Horticulturae 905:107-112.2011.

Keywords biocontrol agent; *CitrusX paradisi*; hydroxyl radical; ROS; superoxide Anion

Abstract

To gain insight into the mode of action of the yeast biocontrol agent, *Metschnikowia fructicola*, the transcription profiles of genes involved in oxidative stress were studied in grapefruit (*Citrus paradisi*, 'Star Ruby') surface wounds following the application of the yeast antagonist. Three transcripts encoding peroxidase (POD), superoxide dismutase (SOD) and catalase (CAT) were selected for temporal expression analysis by quantitative real-time PCR (qPCR). The application of the yeast antagonist on

surface wounds significantly decreased the expression levels of POD and CAT genes compared to control wounds. Moreover, this suppression was correlated with significantly higher levels in hydrogen peroxide, superoxide and hydroxyl production in yeast-treated surface wounds. Together our findings demonstrate that the *M. fructicola* application is involved in regulation of oxidative stress, and acts to induce ROS production in grapefruit.

56 [h012 / b000](#)

Title Characterization of cold-adapted rhizobacteria for control of postharvest fungal decay of pome fruit

Author L.M. Nelson, C. Nagel, N. Bose-Roberts, D. Mantyka, D. Hirkala and P.L. Sholberg

Citation ISHS Acta Horticulturae 905:181-188.2011.

Keywords *Penicillium expansum*; *Botrytis cinerea*, *Mucor piriformis*; temperature; carbon source; pH; cell-free supernatant

Abstract

Fungal decay during postharvest storage of fruit leads to significant losses worldwide. As pathogens become resistant to synthetic fungicides microbial antagonists are promising alternatives, but only one postharvest biocontrol agent has been registered for use in Canada. Plant root-associated rhizobacteria adapted to cold climates may be a potential source of novel biocontrol agents. Four rhizobacteria that were isolated from legumes grown in Saskatchewan soils and suppressed the growth of three major postharvest pathogens of pome fruit, *Penicillium expansum*, *Botrytis cinerea* and *Mucor piriformis* during cold storage were selected for further characterization. Three *Pseudomonas* isolates and one *Serratia* isolate grew well at temperatures from 1 to 28°C and at pH 5-7 and were able to utilize the major sugars, organic acids and amino acids found in apples. Cell-free extracts from one *pseudomonad* isolate inhibited growth of *Penicillium expansum*. This isolate consistently increased medium pH following growth on several media, a factor which may contribute to the suppression of fungal pathogens. These rhizobacteria demonstrate potential for control of fungal pathogens responsible for post-harvest decay of pome fruit.

57 [h032 / b000](#)

Title Characterization of *Rhodotorula glutinis* and *Pichia onychis* isolates with potential as biopesticides for controlling *Botrytis cinerea*

Author J. Zapata, C. Acosta, A. Díaz, L. Villamizar and A.M. Cotes
Citation ISHS Acta Horticulturae 905:155-160.2011.
Keywords yeasts; blackberry; ecophysiological studies; stability; biological control

Abstract

Antagonistic microorganisms are affected by abiotic factors such as pH, temperature UVB radiation and A^w when they are applied to the phyllosphere or undergo a formulation processes. However, the selection and design of a correct formulation and manufacturing process, could contribute to solve this problem. In this sense, three isolates of *Pichia onychis*, Lv027, Lv297 and Lv315 and three isolates of *Rhodotorula glutinis*, Lv316, Lv317 and Lv318 were characterized by determining the effect of pH, temperature, UVB radiation and A^w on growth. The biocontrol activity against *Botrytis cinerea* in blackberry flowers and cells stability under storage conditions were measured when biomass was dried or suspended in an isotonic solution. A^w and UVB radiation were the most limiting factors, when A^w was reduced to 0.94 yeast growth reduction of 80% was observed. The growth of *P. onychis* strains was inhibited completely by UVB, while *R. glutinis* strains showed a growth inhibition between 16 and 42%. Temperatures between 5 and 37°C and pH between 3 and 9 did not affect yeasts growth. The highest stability was obtained for all yeasts, when cells were suspended in the isotonic solution. All evaluated yeasts reduced the incidence of *B. cinerea* between 11 and 81% in comparison with the control (90% incidence). However, isolate Lv316 of *R. glutinis* was selected to continue with a biopesticide development process as an aqueous formulation due to its high biocontrol activity (disease incidence of 18%) and tolerance to the UVB radiation.

58 [h006 / b006](#)

Title Control of blue mold rot on mandarins with gaseous phase of essential oil
Author R. Ben-Arie, E. Kvitnitsky and I. Paluy
Citation ISHS Acta Horticulturae 905:275-281.2011.
Keywords *Citrus reticulata*; *Penicillium italicum*; essential oil; antifungal activity; fumigant; postharvest pathogens; postharvest storage

Abstract

The efficacy of vapor of commercially available GRAS-registered essential oil (MO-1) against *Penicillium italicum*, the pathogen responsible for blue mold rot was evaluated. The best results in the

control of *P. italicum* were obtained by exposing fruit for 24 h to MO-1 applied in a gas phase. The used fruit were inoculated with a suspension of pathogen at 10^6 conidia/ml. The trace quantities of the essential oil vapor reduced decay (Blue Mould Rot) evoked by *Penicillium italicum* on inoculated mandarins by 60-80% after storage at $20 \pm 1^\circ\text{C}$. The test period for non-treated with essential oil (control) fruit was determined as 9 days at 100% of rot development. Sensory tests demonstrated no effect of the treatment on the original taste, smell and appearance of the fruit. The results revealed that the MO-1 tested may be recommended as a natural alternative to chemical preservatives.

59

f999; h999 / b000

Title Control of postharvest decay by the integration of pre- and postharvest application of nonchemical compounds

Author A. Ippolito and S.M. Sanzani

Citation ISHS Acta Horticulturae 905:135-143.2011.

Keywords integrated control; alternative control means; salts; natural substances; biocontrol agent; physical means

Abstract

Traditionally, chemical fungicides have been used to preserve the quality of fruit and vegetables over extended periods of storage or transportation. However, increased global concern about pesticide residues and the reduced efficacy of chemicals due to pathogen resistant strains, have forced producers to evaluate safer alternatives for controlling postharvest diseases in the context of sustainable agriculture. Several means, such as natural compounds of animal and plant origin, organic and inorganic salts, antagonistic microorganisms, and physical means, represent the approaches recently evaluated to ensure fruit quality and safety.

Unfortunately, under commercial conditions these means as standalone treatments rarely yield satisfactory control levels. Lack of a high activity, low persistence, a narrow spectrum of activity, and a failure to control previously established infections can be considered the main limiting factors. Thus, it is generally accepted that a combination of various methods is necessary to improve the efficacy of these alternatives. In this regard, the use of alternative control practices involves the use of both pre- and postharvest strategies that have the potential to reduce latent, quiescent, and incipient infections; pathogen inoculum in the environment; and increase innate resistance in fruit. It has been shown that integrated approaches involving applications of microbial antagonists or other non-chemical means both before and

after harvest can provide rates of disease control comparable to or better than synthetic fungicides, due to additive or synergic effects.

60 [h012; h063 / b000](#)

Title Current status of development of biological control products for postharvest use in Europe

Author B. Vorstermans and P. Creemers

Citation ISHS Acta Horticulturae 905:313-318.2011.

Keywords PPPs; residue restrictions; management; non-chemical alternatives; BCA; biological efficacy

Abstract

In Europe, the pome fruit growing industry is currently confronted with residue restrictions imposed by marketing chains as retail companies and import countries. Next to a high quality product also a limited residue loading on the fruit surface is requested. Particularly the number of active ingredients on the fruit surface is restricted, and also some standard applied plant protection products (PPPs) are prohibited. The chemical fungicides applied shortly before harvest towards fruit rot decay during storage are frequently detected after analytical analysis. Therefore, these chemicals are, at the moment, in the focus of interest of the industry. To this end, research concerning alternative approaches has exploded in the past years. The European government is also stimulating this kind of research indirectly as each member state is demanded to adopt a national action plan to reduce risks and impacts of pesticide use on human health and the environment (Directive 2009/128/EC). In collaboration with the plant protection industry research was done to investigate non-chemical alternatives for postharvest disease control. Several yeast strains were selected and formulated to verify their potential as a biological control agent (BCA). In order to enhance the efficacy, the supplementary effect of natural products and physical treatments is also implemented in this study. As for the application technique in general, a postharvest treatment by dipping, which is a more standardized application where all parameters can be quantified and controlled, is selected. In addition to the fruit surface, also wounds, caused by picking and transport, will be covered resulting in a higher biological efficacy towards key wound pathogens as *Botrytis cinerea* and *Penicillium* spp. Depending on the type of BCA some promising results were obtained. Nevertheless, more research under practical conditions is requested to implement these non-chemical products into an integrated system.

61 [h012; h006; h010; h051; h052; h055 / b000](#)

Title *Cystofilobasidium infirmominiatum* as a biocontrol agent of postharvest diseases on apples and citrus

Author S. Vero, G. Garmendia, M.F. Garat, I. de Aurrecoechea and M. Wisniewski

Citation ISHS Acta Horticulturae 905:169-180.2011.

Keywords biocontrol yeasts citrus apple

Abstract

two psychotrophic yeasts isolated from the surface of cold stored lemons have been selected as biocontrol agents of most common postharvest diseases of apples and citrus, during cold storage. they were identified as *cystofilobasidium infirmominiatum* and *leucosporidium scottii*. both yeasts resulted resistant to three of the fungicides most frequently used in postharvest applications, so a combination of the antagonists with fungicide could be used as part of an integrated management practice. however, the growth of both of them resulted affected by the presence of chitosan, so a combination of treatments would be impracticable. both antagonists were characterized but mechanisms involved in biocontrol activity could not be fully understood. nitrogen competition seemed to play a role but further studies are required to get a final conclusion.

62 [h020 / b000](#)

Title Differential gene expression during the pathogenic interaction between *Pichia fermentans* and peach fruit

Author S. Fiori, B. Scherm, Q. Migheli, M. Budroni, R. Farrel and M. Wisniewski

Citation ISHS Acta Horticulturae 905:103-106.2011.

Keywords dimorphic yeast; biocontrol risks; genes subtraction; *Prunus persica*; *Malus domestica*

Abstract

A biofilm-forming strain of *Pichia fermentans* was found to be a very strong antagonist against brown rot and grey mold in artificially wounded apple fruit when co-inoculated with either *Monilinia fructicola* or *Botrytis cinerea*, respectively. The same strain of yeast, however, was an aggressive pathogen when inoculated on peach fruit, causing rot of fruit tissues, even in the absence of other

pathogens. Optical and scanning electron microscopy showed that *P. fermentans* produces only yeast-like shaped cells during colonization of apple tissue, while exhibiting pseudohyphal growth on peach tissue. A rapid subtractive hybridization approach (RaSH) was used to identify differentially expressed genes in the pathogenic form of *P. fermentans* by comparing the cDNA of *P. fermentans* sampled after 24 hours growth on apple with the cDNA of the same strain grown 24 hours on peach fruit. A total of 450 clones were analysed by a reverse Northern Blotting technique, yielding some fragments which were significantly expressed on peach but less on apple tissue. These sequences were compared to the available genome sequences of another dimorphic yeast, *Candida albicans*, and homologous genes were identified. The relationship between these genes, dimorphism, and pathogenicity will be discussed.

63

[h999 / b000](#)

Title Diversity and antimicrobial activities of endophytic fungi isolated from *Myrcia sellowiana* in Tocantins, Brazil

Author W.S. Pinto, M.C. Perim, J.C. Borges, R.S. Pimenta, L.H. Rosa, J.F.M. Silva and W.J. Janisiewicz

Citation ISHS Acta Horticulturae 905:283-286.2011.

Keywords bioactive substances; volatile; *Monilinia fruticola*; *Colletotrichum gloeosporioides*; *Aspergillus parasiticus*; biological control

Abstract

One hundred and forty five isolates of endophytic fungi were recovered from leaves and branches of the medicinal plant, *Myrcia sellowiana*, in Brazil. All isolates were purified on PDA and the strains were grouped into 50 morphotypes. Each isolate was tested for production of volatiles and agar diffusible substances inhibitory to *Monilinia fruticola* (MF), *Colletotrichum gloeosporioides* (CG) and *Aspergillus parasiticus* (AP). Antagonistic activity was exhibited by 41 strains belonging to 4 morphotypes. Thirty eight of these strains were from one morphotype and the remaining three strains were each from different morphotypes. Thirty one produced diffusible substances that inhibited growth of both CG and AP, 6 were active only against AP, 3 against CG and only one against MF. Thirty-five strains produced inhibitory volatiles, thirty-one of them produced volatiles against both CG and AP, two only against CG, and two only against AP. No strain produced antagonistic volatile substance against MF. All strains that produced inhibitory volatiles also produced diffusible inhibitory substances in PDA medium. Only 6 strains produced diffusible active substances but no inhibitory volatiles. Interestingly, the high number of

inhibitory interactions against CG and AP (27.3% of total isolates tested) is in contrast to the low number of inhibitory interactions against MF (only 0.6%). This may be due to co-evolution of *M. sellowiana* and CG and AP, and the absence of MF in this region of Brazil. These results indicate that medicinal plants in Brazilian ecosystems are a good source of antagonistic endophytic fungi producing diffusible and/or volatile substances against postharvest pathogens. Currently our research is focused on molecular identification of strains, determining biocontrol efficacy on fruits, and characterization of the inhibitory substances.

64

[h012 / b000](#)

Title Effect of heat shock treatment on stress tolerance and biocontrol efficacy of biocontrol yeasts

Author J. Liu and M. Wisniewski

Citation ISHS Acta Horticulturae 905:227-232.2011.

Keywords heat shock; *Metschnikowia fructicola*; *Candida guilliermondii*; stress tolerance; biocontrol efficacy; trehalose

Abstract

Several different species of yeasts have been used as biocontrol agents against postharvest diseases of fruits and vegetables. Our current research is directed to develop a better understanding of yeast biology in relation to biocontrol activity and to develop strategies to improve the efficacy of their biocontrol activities. The effect of a mild heat shock (HS) pretreatment (30 min at 40°C for *Metschnikowia fructicola*; or 20 min at 40°C for *Candida guilliermondii*) on the tolerance of to subsequent high temperature (45°C) and oxidative stress (0.4 mol L⁻¹ H₂O₂) was evaluated. The viabilities of the two yeasts subjected to both stresses were enhanced by the pretreatment. Additionally, the HS yeasts showed better biocontrol efficacy against *Penicillium expansum* and higher population on apple fruits stored at 25°C compared to the performance of untreated yeast cells. The trehalose content in *M. fructicola* or *C. guilliermondii* also increased. Results indicate that induction of trehalose content by HS pretreatment may contribute to improvement in stress tolerance, population dynamics and biocontrol efficacy of the two biocontrol yeasts.

65

[h006 / b000](#)

Title Effects of temperature and relative humidity on the in vitro and in vivo radial growth of *Penicillium italicum* and on the biocontrol activity of *Pichia guilliermondii*, strain Z1

Author M. El Guilli, M. Ibriz, R. Lahlali and M.H. Jijakli

Citation ISHS Acta Horticulturae 905:233-240. 2011.

Keywords Citrus; *Penicillium italicum*; temperature; relative humidity; *Pichia guilliermondii*

Abstract

The objective of this study was to assess the effect of temperature (5-25°C) on the 'in vitro' and 'in vivo' growth rates of *Penicillium italicum* and to determine the combined effect of temperature and relative humidity (45 to 100%) on lesion size of this pathogenic fungus on Valencia late oranges, either alone or in combination with the antagonistic yeast strain Z1 of *Pichia guilliermondii* Wickerham. Statistical analysis showed a significant effect of temperature on the 'in vitro' and 'in vivo' radial growth of *P. italicum* with the maximum growth observed at temperature of 25°C. In both cases, no growth was observed at a temperature of 35°C. These factors had a significant effect on *P. italicum* lesion size when it was applied alone on Valencia late oranges and insignificant when yeast strain Z1 was applied 24 h before *P. italicum* inoculation. Our results confirm previous 'in vitro' findings that a_w has a greater influence than temperature on *P. italicum* growth and highlight that the strain Z1 showed high antagonistic potential against this pathogen over a range of temperature-relative humidity regimes favouring *P. italicum* development.

66 [h020 / b000](#)

Title Historical perspective on biological control of postharvest diseases - past, present, and future

Author C.L. Wilson, M. Wisniewski, S. Droby and E. Chalutz

Citation ISHS Acta Horticulturae 905:23-28.2011.

Keywords biological control; postharvest; antagonists; epiphytes; biofungicides; natural fungicides; chitosan; UV-C light; hormesis; microecology; synthetic biology

Abstract

The birth of the field of biological control of postharvest diseases can be traced back to 1984 when a researcher testing an antagonist (*Bacillus subtilis*) in the field to control brown rot of peaches

(caused by *Monilinia fructicola*) decided to apply the antagonist directly to the peach to control brown rot. The results were striking. It became apparent from this simple experiment that postharvest diseases and biocontrol were meant for each other. The advantages of applying biological control practices in the packinghouse vs. the field became clear. Biological control holds great promise of providing an alternative to present postharvest chemical fungicides for the control of postharvest diseases and reducing the health and environmental hazards presented by synthetic fungicides. Researchers around the world have been pursuing the use of antagonistic yeasts and bacteria as such alternatives and registered products are now on the market. The major shortcoming of these first products has been their lack of an eradicant action. In other words once a postharvest infection occurs the antagonist is unable to arrest it. This has required the addition of low dosages of synthetic fungicides with the antagonist in order to reach levels of disease control comparable to the synthetic fungicide alone. The early concept of postharvest biocontrol as being a one on one relationship between an antagonist and a pathogen limited approaches to the development of this technology. Using an expanded concept, combinations of antagonists with natural fungicides and physical treatments that induce host resistance are yielding more effective control and enhancing the potential of postharvest biocontrol. Advances in the fields of molecular biology and microecology hold promise for a better understanding of postharvest biocontrol systems and expanding the application of postharvest biocontrol strategies. There is the potential of identifying and manipulating “biocontrol genes” in antagonists to produce more effective antagonists. Genes in antagonists responsible for suppression of pathogens have also been used to screen for more effective antagonists. There is evidence that plants can genetically control epiphytes on their surfaces that contribute to biocontrol. This presents the prospect that “biocontrol genes” can be identified in postharvest commodities that will promote suppressive epiphytes and thus reduce the development of postharvest diseases.

67

[h039; h067 / b000](#)

Title Identifying and characterizing microflora of stone fruits to select antagonists for control of brown rot with emphasis on latent infections

Author W.J. Janisiewicz, J.S. Buyer and C.P. Kurtzman

Citation ISHS Acta Horticulturae 905:241-250.2011.

Keywords *Monilinia fructicola*; postharvest biocontrol; fruit decay; fungicide alternatives

Abstract

Fruit surface microflora has been the most productive source of antagonists against fungi causing postharvest decays of fruit. The establishment of populations of these organisms and their interaction with decay causing pathogens in fruit wounds has been the basis for the development of current postharvest biological control systems. However, many pathogens, including *Monilinia fructicola*, the causal agent of brown rot of stone fruits, can also infect fruit through undamaged tissue in the orchard by producing latent infections that are activated as fruit ripens in storage, resulting in decay. We characterized culturable bacteria and yeast resident microflora of nectarine fruit from early development until harvest over a two year period. Time of isolation was a significant factor in the frequency of occurrence of different bacteria during fruit development, indicating a succession of the genera. However, for yeasts, only the last sampling time was distinct from the earlier samplings, indicating the presence of more specialized yeasts on mature fruit. Conventional screening of these microorganisms, for biocontrol of brown rot originating from wound infections on nectarines and plums, resulted in the isolation of several effective antagonists, which constituted only about 2% of all microorganisms tested. We developed a new technique, involving in vitro and in situ tests, for detecting bacteria and yeasts able to control latent infections of *M. fructicola* on stone fruits. This new approach can also be used in other fruit systems, including latent infections caused by *Colletotrichum* spp., and may result in the development of the next generation of biocontrol agents.

68

[h999 / b000](#)

Title Improving the efficacy of postharvest biocontrol agents - production of environmental stress tolerant formulations

Author N. Teixidó, J. Usall, R. Torres, M. Abadias and I. Viñas

Citation ISHS Acta Horticulturae 905:221-226.2011.

Keywords biological control; compatible solutes; fluidized bed drying; freeze drying; improving environmental stress resistance; spray drying

Abstract

The limited tolerance of many biocontrol agents to fluctuating environmental conditions and the difficulty of developing a shelf-stable formulated product able to resist these stress conditions (low water activity and high temperatures) and still be as effective as fresh cells is one of the main reasons for the limited commercial availability of biocontrol agents (BCAs). Thus, improvement in the stress tolerance of

BCAs during production, that can lead to better survival and activity under suboptimal environmental conditions, is an important challenge.

In general, microorganisms are able to survive environmental stress by the induction of specific or general protection systems, such as cytoplasmic accumulation of endogenous reserves (compatible solutes) or heat shock protein biosynthesis. Subjection to a mild stress can make cells resistant to a subsequent lethal challenge of the same stress and can also render cells resistant to other stress conditions (cross protection). This natural capacity has been used during formulation of BCAs to improve their stress tolerance when they are later used in a commercial application.

Research studies directed at improving *Candida sake* CPA-1 and *Pantoea agglomerans* CPA-2 (well-known postharvest BCAs) stress tolerance have been conducted. Results have been achieved that improve their tolerance to osmotic, thermal and pH stresses. The use of stress-adapted formulations of BCAs has resulted in enhanced biocontrol efficacy under field conditions and broadened their spectrum of action.

69

[h999 / b000](#)

Title Industry perspective on commercializing biocontrol for postharvest disease management
Author C. Jewell
Citation ISHS Acta Horticulturae 905:289-298.2011.
Keywords *Candida oleophila*; *Pseudomonas syringae*; *Muscodor albus*; packingline; biological control

Abstract

JBT FoodTech is a postharvest service company that partners with fresh produce packers to provide a host of tools they need to ensure quality arrivals in various world markets. Many of the products that JBT offers are produced and developed in-house, but many others are the product of partnerships with companies looking to commercialize products they have discovered/developed into the postharvest arena. In this capacity, JBT has had the opportunity to work with a few biological control products over the past two decades. Each presented unique opportunities and challenges, and while some hurdles were overcome, there are still many that must be tackled. The experiences with these partnerships are discussed, along with a summary of the perceived challenges and needs for biocontrol in the future from JBT's perspective.

70

[h999 / b000](#)

Title Integrated approaches to postharvest biocontrol
Author S. Vero and G. Garmendia
Citation ISHS Acta Horticulturae 905:123-134.2011.
Keywords disease management; physical treatments; antagonists; heat treatments

Abstract

The use of biocontrol agents to inhibit postharvest pathogens has shown great potential. However, there have been many obstacles to their implementation as a feasible commercial strategy. A lack of understanding of how to integrate microbial agents with commercial processing practices in packing houses has been one of the main problems. Many physical and chemical treatments intended to minimize postharvest losses are also being incorporated into standard processing lines. A detailed analysis of the possible interactions of these alternative treatments with biocontrol agents is essential to achieve successful results. This paper reports a number of treatments that are used in combination with biocontrol agents and discusses the potential of an integrated approach to minimize postharvest losses.

71

[h006; h010 / b000](#)

Title Integrated approaches to postharvest disease management in California citrus packinghouses
Author J.L. Smilanick
Citation ISHS Acta Horticulturae 905:145-148.2011.
Keywords oranges; lemons; *Penicillium digitatum*; *Penicillium italicum*; blue mold; green mold

Abstract

Practices in the citrus industry evolve rapidly to minimize postharvest decay losses, mostly a result of green mold or blue mold, caused by *Penicillium digitatum* or *P. italicum*, respectively. Current problems include the continued development of fungicide resistance among these pathogens, and compliance with emerging secondary residue standards and other privatized regulation of production and postharvest practices, the rising popularity of new cultivars (such as mandarin oranges, where natural decay resistance is low) and the decline of others (such as Valencia oranges, where natural decay resistance is high), and marketing issues, including exceptionally long storage for distant markets or a

requirement for food safety interventions, such as chlorination at high rates. Recently (since 2000) introduced practices in California include fungicide bin drenching of harvested fruit on transit trailers, the use of fungicides in aqueous solutions rather than in waxes to improve their performance, the application of sodium bicarbonate or potassium sorbate in heated tanks or through high-pressure washer nozzles, ozonation of storage rooms to oxidize ethylene and retard sporulation of *Penicillium digitatum* and *P. italicum*, and the introduction of new fungicides (pyrimethanil, azoxystrobin, fludioxonil). Recently evaluated experimental practices include pre-harvest applications of fungicides and growth regulators, mycofumigation with natural volatiles from the fungus *Muscodor albus*, UV-assisted sorting to remove fruit with mechanical injuries before storage (since these later decay at a high frequency), thermal and chemical disinfection of packinghouses and storage rooms, and the use of phosphites before and after harvest.

72

[f999](#); [h999](#) / [b006](#)

Title Integration of biocontrol strategies into organic production of horticultural crops

Author R.K. Prange

Citation ISHS Acta Horticulturae 905:149-154.2011.

Keywords biopesticide; dynamic controlled atmosphere; heat treatment; UV-C treatment; decay control; fungi; bacteria; anti-microbial surfaces; liquid glass

Abstract

Most of the research and development of acceptable organic technologies has been pre-harvest-oriented. There has been little effort to provide new post-harvest technologies for organic products, resulting in insufficient post-harvest methods being available for organic fruits and vegetables. The greatest need is to develop strategies to control post-harvest decay. For some products, there is an additional need to replace chemicals being used to control postharvest disorders or insect infestation; some of which may no longer be available, e.g. diphenylamine in the EU after May, 2010. Organically-acceptable postharvest decay control will depend on the introduction of effective biopesticides and anti-fungal biocontrol agents. The terms 'biopesticide' and 'biocontrol agent' will be defined and compared. The issues of efficacy and acceptability for organic production will be reviewed, i.e. approval of a biopesticide or biocontrol agent does not guarantee efficacy or acceptability in organic production. Increasing efficacy by combining biopesticides or biocontrol agents with other 'organically-accepted', non-chemical technologies will need to be encouraged. Recent advances in Controlled atmosphere (CA)

technology, e.g. Dynamic CA (DCA), will be discussed since CA technology is a known technology that, depending on the commodity, can maintain quality as well as reduce decay and/or eliminate the use of insect and disorder-controlling chemicals. Other non-chemical post-harvest technologies which may be successful will also be discussed, e.g. UV-C treatment, heat treatment, anti-microbial surfaces. More research is needed on each of these technologies, both singly and in combination with each other.

73 [h012 / b000](#)

Title Metagenomic approach to tracking microorganisms on apples - a case study
Author D.M. Glenn, C.L. Bassett and S.E. Dowd
Citation ISHS Acta Horticulturae 905:83-86.2011.
Keywords *Malus domestica*; pyrosequencing; fungi; postharvest pathogens; particle film

Abstract

An understanding to the microflora species composition and frequency on apple trees is important in understanding the potential for biocontrol to succeed. Ultraviolet radiation (UV) is an environmental factor that limits microbial growth and SurroundTM particle film is highly reflective of UV radiation and may provide an effective ‘umbrella’ of protection. Leaf and fruit washings were made in July and September of 2007 and in August and September of 2008 of ‘Empire’ apple production systems. The systems were: 1) organic production based on Surround particle film for insect control and wettable sulfur for disease control, 2) conventional pesticide program, and 3) conventional pesticide program with the addition of Surround particle film. DNA was extracted from the washings and used as template for amplification of 16S rDNA (bacterial) and 18S rDNA (fungal). The amplicons were subjected to 454 sequence analysis using standard software for taxonomic identification. The results indicated that species diversity was increased by the presence of the Surround particle film with or without synthetic pesticides. These results demonstrate that sensitive tools are available to survey change in microbial populations and a metagenomic approach to microbial ecology has value in the agricultural setting.

74 [h012 / b006](#)

Title *Metschnikowia andauensis*: a novel biocontrol agent of fruit postharvest diseases
Author T. Manso and C. Nunes
Citation ISHS Acta Horticulturae 905:261-268.2011.

Keywords *Botrytis cinerea*; citrus fruit; mechanism of action; *Penicillium expansum*; pome fruit; *Rhizopus stolonifer*

Abstract

A new yeast antagonist, *Metschnikowia andauensis* PBC-2, isolated from apple fruit, was evaluated for its biological control activity against the most important postharvest pathogens of pome and citrus fruit. This yeast at 10^7 cfu ml⁻¹ was very effective in reducing blue mold caused by *Penicillium expansum* on different cultivars of apples and in ‘Rocha’ pear, and against *P. digitatum* and *P. italicum* on citrus fruit. High control of *B. cinerea*, *P. expansum* and *R. stolonifer* was obtained with the application of *M. andauensis* PBC-2 on ‘Golden Delicious’ apple. Over more than four years of experiments in semi-commercial trials *M. andauensis* PBC-2 provided excellent control against *P. expansum* under cold storage. The mechanisms of action, as antibiosis, production of chitinolytic enzymes and iron competition were studied. Results showed that none of these mechanisms were responsible for the antagonistic ability of *M. andauensis*. Research is now in progress to examine different media, in order to optimize large-scale production.

75 [h061 / b006](#)

Title Natural and safe alternatives to conventional methods to control gray mold of table grapes in storage

Author G. Romanazzi, F.M. Gabler, A. Lichter and J.L. Smilanick

Citation ISHS Acta Horticulturae 905:161-168.2011.

Keywords *Botrytis cinerea*; blue mold; grey mould; postharvest decay; *Vitis vinifera*

Abstract

Gray mold, caused by *Botrytis cinerea*, is the main postharvest decay of table grapes. It can develop in the vineyard and spread rapidly among berries after harvest, during long distant transport, cold storage and shelf life. Harvested bunches are usually stored in the presence of sulfur dioxide. However, the use of synthetic fungicides and of sulfur dioxide is not allowed on organic grapes and the study of alternative means to control postharvest decay has developed during several decades, along with the expansion of organic agriculture. We can group these approaches as follows: i) biocontrol agents; ii) natural antimicrobials; iii) GRAS type decontaminating agents; and iv) physical means. Two biocontrol agents, *Muscodora albus* and *Hanseniaspora uvarum*, have shown equal or better effectiveness than

conventional means to control gray mold of table grapes in laboratory scale experiments. Currently, the bottleneck regarding the commercial use of biocontrol agents is that the registration process is comparable to that of fungicides, with similar costs but often with a narrower market. Natural antimicrobials, such as salts, chitosan, and plant extracts, demonstrated good results and often were applied in semi-practical or practical conditions. Several GRAS-classified sanitizers were tested to extend postharvest storage of table grapes, including acetic acid, electrolyzed oxidizing water, ozone, and ethanol, although the GRAS status of some of these compounds is dose-dependent or questionable. Physical means in reference to variations in temperature, radiation, pressure or changing atmospheric composition are all postharvest practices which require significant adaptation by the industry which is accustomed to minimal intervention during harvest. Overall, the use of ozone and of calcium chloride are two successful examples moved to practical application. Improved understanding of the various methodologies and their mode of action will lead to further optimization of the treatments and to generation of novel combinations to control postharvest decay of table grapes. The possible requirements that alternative means should have for the application in the table grape fields and/or packinghouses were summarized.

76 [h012; h020; h006; h010; h051; h052; h055 / b000](#)

Title Novel role for reactive oxygen species (ROS) in host-antagonistic yeast-pathogen interactions in postharvest biocontrol systems

Author D. Macarisin, G. Bauchan, S. Droby and M. Wisniewski

Citation ISHS Acta Horticulturae 905:113-119.2011.

Keywords postharvest biological control; antagonistic yeast; reactive oxygen species; superoxide anion; hydrogen peroxide

Abstract

To achieve the full potential of postharvest biocontrol microorganisms as a viable commercial technology, fundamental knowledge on their mechanisms of action is crucial. After more than 20 years of postharvest biocontrol research there is still limited understanding of interactions taking place between the host, the pathogen, and the antagonist mainly due to difficulties associated with the study of this complex system.

Our recent research showed that various antagonistic yeasts used to control postharvest diseases (*Metschnikowia fructicola*, *Candida oleophila*, *Candida saitoana*, and *Pichia guilliermondii*) secreted high, transient levels of superoxide anion as they colonized wounded host tissue and intact surfaces of

apple, peach and citrus fruits. The application of *Metschnikowia fructicola* and *Candida oleophila* into citrus and apple fruit wounds induced a significant ($P \leq 0.05$) increase in hydrogen peroxide accumulation in host tissue. Importantly, living cell of *M. fructicola* were detected on the third day after inoculation in fruit wounds exhibiting a high level of host-generated hydrogen peroxide indicating the ability of this yeast to tolerate elevated levels of host ROS. ROS-tolerance may be an essential characteristic of effective yeast antagonists. These data, together with our earlier finding on the importance of hydrogen peroxide in the mechanism of fruit defense against postharvest pathogens, indicate that the ability of yeast antagonists to self-generate and possibly stimulate an oxidative response in host tissue could be one of the major factors underlying the performance of a biocontrol agent.

77

[h012 / b006](#)

Title Postharvest rotting, quality and shelf life of apple as affected by chemicals, GA treatment and packaging

Author S.K. Sharma, M.C. Nautiyal and K. Issar

Citation ISHS Acta Horticulturae 905:201-209.2011.

Keywords apple; *Malus × domestica*; CaCl₂; GA, bavistin; rotting; waxing; ZECC; ambient; modified atmosphere

Abstract

Postharvest infrastructure is inadequate in India and losses are high. Cold storage facilities are scarce and beyond the reach of most growers. Therefore, this study was undertaken to find a low cost solution for short term storage of apple in Uttarakhand state. Storage studies of apples harvested at optimum maturity were undertaken at ambient and zero energy cool chamber (ZECC, a low cost cold storage structure for short term storage of fruits and vegetables) conditions for 100 days. The effect of various postharvest treatments i.e. waxing, CaCl₂, fungicide (Bavistin) dip and GA₃ was also evaluated for control of postharvest diseases/ rotting and quality of fruits during storage. Results indicated that apple fruits treated with 10% Nipro fruit wax and stored under ZECC conditions were found to be the best in terms of shelf life and quality. The physiological loss in weight was lower under ZECC i.e. (2.28%) while, it was as high as 7.93% under ambient conditions. Storage of fruits under modified atmosphere also reduced physiological weight loss. The incidence of postharvest diseases occurring as rotting due to natural fruit surface pathogens were reduced with CaCl₂ and Bavistin application during storage. When we compared temperatures, it was found that there was a reduction of 7.1°C in mean minimum temperature

and 12.2°C in mean maximum temperature in the ZECC as compared to the ambient conditions. Additionally, a humidity of 90% was maintained in the ZECC continuously during the fruit storage studies. So, apple fruits can be successfully stored under ZECC (temperature 3.10 to 19.80°C, RH~ 90%) for a period of about 100 days after treatment with 10 %wax and treatment with 2.5% CaCl₂ or Bavistin (200 ppm) after packing in micro perforated polythene bags, with minimum postharvest disease incidence, and quality changes. This technology along with the use of 1-MCP can prove successful for on-farm storage of apple by the resource poor farmers in India.

78 [h020; h061; h006; h010; h051; h052; h055 / b006](#)

Title Postharvest use of non-chemical control strategies in Turkey
Author P. Kinay-Teksur
Citation ISHS Acta Horticulturae 905:307-311.2011.
Keywords biological control; postharvest; integration; physical control

Abstract

Due to residue and resistance problems with fungicides, many attempts have been made in recent years to find alternatives to chemical control. In this regard, biological and physical methods have great potential. Based on recent research in this area, some studies on the biological control against postharvest diseases have been carried out in Turkey. These studies have focused on the use of antagonistic yeasts. *Metschnikowia pulcherrima* (on mandarin and grape), *Pichia guilliermondii* (on citrus), and *Kloeckera apiculata* (on peach) have been found to be effective against postharvest decays in these commodities. In our studies, antagonistic yeasts were applied either before or after harvest. Bioformulations of several effective antagonistic yeast isolates have been developed and pilot tests were carried out on citrus under packinghouses conditions. Additionally, select preharvest treatments such as plant growth regulators (GA₃ and 2,4-D), CaCl₂, hot water, curing, UV-C, low doses of fungicides, and sodium bicarbonate were integrated with yeast isolates to enhance their efficacy.

79 [f999; h999 / b000](#)

Title Registry and regulation of biocontrol agents on food commodities in South America
Author A.M. Cotes
Citation ISHS Acta Horticulturae 905:301-306.2011.
Keywords biopesticides; registration; legislation; South America; biodiversity

Abstract

The use of biological control agents as an integral component of biologically-based pest management strategies has had increased awareness during the last decades. Microbial pesticides have been successfully promoted to farmers in many countries of South America, mainly in systems where not chemical pesticides are available or when pest/disease resistance has made chemical alternatives increasingly expensive and or unreliable. Although farmers in general show a high level of satisfaction with the microbial pesticides they also recognize technical shortcomings with the current generation of biopesticides that will require further technical development to overcome. Faster and reliable action, good storage characteristics and technologies to apply are the main constrains considered. Brazil, Chile and Colombia have 17, 36 and 48 biocontrol products registered in 2010, respectively. However, regulation is critical for the development of biological control; there are differences in time and expenses involved in registration where there is a regulatory system. In some countries there is not regulation for biopesticides, in others as in Brazil and Chile the legislation is the same for chemical pesticides, although in Brazil, a decree establishing the criteria for registration of BCAs for organic agriculture was approved in July 2009, and in others as in Colombia, since 1994 there is a specific regulation, which was updated in 2004. Thus, the low quality of some products and the regulatory and bureaucratic problems related to registration process are responsible for the increased number of illegal biocontrol products in South America.

80

[h012 / b006](#)

Title Restorative biological control - a promising new approach, but can we prove it?

Author K. Everett, J. Rees-George, S. Pushparajah, I. Hallett, J.L. Vanneste, J. Yu, D.A. Cornish, K. Boyd-Wilson and M. Walter

Citation ISHS Acta Horticulturae 905:269-274.2011.

Keywords *Malus domestica*; calcium chloride; postharvest; *Colletotrichum acutatum*; bitter rots

Abstract

A new approach to biological control is to enhance the populations of biocontrol organisms already present on the surface of the crop to be protected by the use of benign interventions. Several compounds reported in the literature to promote growth of microorganisms were screened for efficacy against *Colletotrichum acutatum*, the cause of bitter rot of apples, on detached fruit. Calcium chloride inhibited lesion diameter on inoculated apples, and when applied in combination with three biocontrol

active yeast isolates (*Aureobasidium pullulans* Y2, *Rhodosporidium diobovatum* Y8 and *Cryptococcus* sp. Y9), the lesion diameter was inhibited more than by either treatment by itself. In field trials for two seasons, calcium chloride controlled bitter rots of apples. In the second season, control of field-expressed disease was as effective as that with a standard fungicide regime. Although control of rots postharvest was still statistically significant ($P < 0.05$) after 16 weeks' coolstorage, calcium chloride was not as effective as the fungicides. A biocontrol agent (*Serratia marcescens* HR42) was also applied inundatively in the second field experiment, and significantly controlled postharvest rots for up to 12 weeks' storage but not after 16 weeks. The identification and comparison of microorganisms isolated from washed fruit from the different treatments failed to demonstrate any differences associated with those treatments that controlled rots. Apple fruit skin is being examined microscopically to determine if the calcium promoted visible changes in the surface and cell wall structures. At this stage in our research, it is not clear if calcium chloride applied in the field is controlling bitter rot by enhancing biocontrol organisms or by some other means.

81

[h012 / b000](#)

Title The role of competition for iron and cell wall degrading enzymes in mechanism of action of postharvest biocontrol agents

Author D. Spadaro, D. Zhang, A. Garibaldi and M.L. Gullino

Citation ISHS Acta Horticulturae 905:87-102.2011.

Keywords apple; *Aureobasidium pullulans*; *Botrytis cinerea*; chitinase; glucanase; *Metschnikowia pulcherrima*; protease

Abstract

The role of competition for iron and production of cell wall degrading enzymes by the antagonists *Metschnikowia pulcherrima* MACH1 and *Aureobasidium pullulans* PL5 against *Botrytis cinerea*, *Monilinia laxa* and *Penicillium expansum* were studied on postharvest fruits. In presence of lower concentration of Fe^{3+} , MACH1 showed higher biocontrol activity. In absence of Fe^{3+} , MACH1 exhibited the highest antimicrobial activity, but sufficient Fe^{3+} enabled the disappearance of the activity, suggesting that competition for iron played a key role in the biocontrol activity of MACH1 against the pathogens. In Lilly-Barnett minimal salt medium with the fungal cell walls of the pathogens as sole carbon source, PL5 produced exo-chitinase, endo-chitinase, and α -1,3-glucanase. The extracted crude enzymes produced by the antagonists showed a high activity in inhibiting the growth of the pathogens in vitro. Our results

showed that competition for iron was the main mode of action of MACH1 and that production of chitinase, glucanase were involved in the biocontrol activities of PL5.

82

[f008 / b006](#)

Title UV-C-induced disease resistance in tomato fruit is a multi-component and time-dependent system

Author M.T. Charles, J. Arul and N. Benhamou

Citation ISHS Acta Horticulturae 905:251-260.2011.

Keywords ultraviolet-C hormesis; *Botrytis cinerea*; phytoalexin; rishitin; phenolic compounds; lignifications; suberization; pathogenesis-related proteins; structural barrier; ultrastructure

Abstract

The induction of disease resistance in a variety of postharvest crops by ultraviolet (UV)-C radiation is well established, although the physiological and biochemical basis of the induced resistance has not been fully elucidated. Mature green tomatoes were treated with a hormetic dose of UV-C and stored for 35 days. The present study focused on the interactions between UV-C-treated tomato fruit and *Botrytis cinerea* over the storage period, in comparison with untreated control fruit, using chemical assays, electrophoresis, and ultrastructural and histochemical techniques. The resistance of UV-C-treated fruit developed gradually and was evident three days following treatment, with resistance reaching a peak level around 15 days after treatment and remaining steady thereafter until the end of storage. The evidence suggests that UV-C-induced disease resistance is a multi-component system with different dynamics and chronology. The accumulation of the phytoalexin, rishitin, accounted for early defence against infection. Ultrastructural modifications in the epicarp lead to the formation of a physical barrier hindering *B. cinerea* ingress. The reinforcement of that barrier and cell walls by simple phenolic compounds, lignin, and suberin provide additional protection against maceration by fungal enzymes. Furthermore, UV-C enhanced the levels of both constitutive and inducible β -1,3-glucanases. The lytic enzyme defences developed gradually over three days, reaching maximum levels at 15 to 20 days and remaining steady thereafter. In contrast, the phytoalexin level declined over the same time period. Although molecular defences are also induced in response to infection alone, their effectiveness is reduced by the slowness of their induction. Pre-establishment of those mechanisms by UV-C treatment arguably gives the tissue a head start in fighting the infection.

83 [f999; h999 / b000](#)

Title Alliances between the state and private companies to improve handling of fresh horticultural products in Costa Rica

Author F. Marín-Thiele

Citation ISHS Acta Horticulturae 906:93-97.2011.

Keywords postharvest; government; private sector

Abstract

An analysis of the impact of the association state and entities and private sector on quality of horticultural perishable produce is provided. This work is presented as a compilation of personal observations and particularly based on two case studies conducted during my administration as head of the postharvest technology area of the State Production Council (CNP) of Costa Rica. In both cases, the government established a good relationship understanding, facilitating and auditing particular scenarios through a formal process of applied research. However, the response of the users to the results varied. There were changes in business strategies, adjustments to the operations, etc., but it was evident that not always the result is immediately used for the benefit of the company. The state and the private sector need to develop long lasting relationships, and not necessarily permanent links, supported for a mutual eager interest in the activity. In conclusion, the strategic alliances must be under a working policy, in other words, there must be an institutional interest and not just interest of individuals. The effects on production, rights of consumers and integrity of the activities will define the sustainability of the relationship.

84 [h001 / b000](#)

Title Aroma volatiles emissions from mango fruit: a closer look at various pre- and postharvest regulatory factors

Author Z. Singh

Citation ISHS Acta Horticulturae 906:267-273.2011.

Keywords *Mangifera indica* L.; aroma volatiles; rootstock; storage; ripening

Abstract

Flavour is comprised of aroma and taste. Volatile compounds are the major constituents of fruit aroma, which are important in defining fruit quality and influencing consumer preferences. This paper will present the information on fundamental and applied aspects of aroma volatile production in mango fruit. Aroma volatile compounds have been reported to be influenced by various factors including the mango species, cultivars, location, fruit maturity at harvest, ripening conditions, processing and storage. The aroma volatiles found in mangoes may be classified according to various groups including monoterpenes, sesquiterpenes, lactones, aromatics, alcohols, esters, ketones, organic acids and aliphatic hydrocarbons. For about a decade, my research group has been exploring the effects of various pre- and postharvest factors on aroma volatiles production in mango fruit. We have identified 61 aroma volatile compounds from the 'Kensington Pride' mango fruit pulp, using a head space solid phase micro-extraction (SPME) technique with gas chromatography (GC) and GC combined with mass spectrophotometry (GC-MS). Effects of rootstock, harvest maturity, ripening temperature, plant growth regulators, edible coatings, storage conditions and various postharvest disease control methods on aroma volatile production will also be discussed. Low temperatures during storage induced chilling injury and reduced the production of aroma volatile compounds during fruit ripening and in fully ripe fruits. Controlled atmosphere storage has also been shown to reduce aroma volatile production in 'Kent', 'Kensington Pride' (KP), and 'R2E2' mango. The aroma volatiles profiles of these commercial cultivars of mango may be a baseline for developing new quality standards in future as the 'quality' expands beyond the common parameters. The mango industry needs to consider and review its postharvest procedures affecting this flavour component to maintain and/or build the consumer confidence.

85 [h004 / b006](#)

Title Control of plantain (*Musa paradisiaca*) fruit rot caused by *Fusarium verticillioides* using heat treatment

Author A.T. Aborisade and O.M. Akomolafe

Citation ISHS Acta Horticulturae 906:155-159.2011.

Keywords plantain; decay; control; disease; heat treatment

Abstract

The control of plantain fruit decay by *F. verticillioides* initiated at the stalk was carried out using prestorage heat treatment - hot air (HA), steam (ST) and hot water (HW). Green, mature fruits harvested 80, 90 and 100 days after shooting were used. In preliminary experiments, HA and ST were tested at 50-

55°C for 1, 2, 3 h to identify the temperature-time range of efficacy for disease control. These were then tested at narrower ranges which were different and specific for each heating method. Earlier investigations had identified the useful temperature-time combinations for HW, so the effect of fruit maturity on response to these treatments was investigated. All fruits were stored at 28°C and 98-100% RH after heat treatment. Results show that the stage of fruit maturity affected the efficacy of the various treatments. Fruits harvested at 100 days after shooting were the least responsive to HA and ST but HW at 53°C for 3 min and 50°C for 5 min was very effective on them. There was no significant advantage of prestorage HA treatment on 80 and 100-day fruits but significant disease control occurred in 90-day fruits with treatment at 50°C for 50 min. Significant disease control also occurred with steam treatment at 50°C for 5 and 40 min in 80- and 90-day-old fruit which remained healthy throughout their 50 days of storage. For 100-day-old fruit, ST treatment was effective in decay control till the 20th day of storage only; by which time control fruits were 90% rotten. HW controlled decay on all ages at the two treatment types tested. All heating methods tested showed potential benefit in decay control.

86

[h056 / b007](#)

Title Critical points in the marketing chain of arazá (*Eugenia stipitata* mcvaugh)
Author M.P. Carrillo, M.S. Hernández-Gómez, J. Barrera, O. Martínez and J.P. Fernández-Trujillo
Citation ISHS Acta Horticulturae 906:25-29.2011.
Keywords empaques; 1-metilciclopropeno; maduración; calidad de fruto; daños mecánicos

Abstract

In the amazonian state of Caquetá (Colombia), more than 365 families have included arazá as part of the agroforestry production in conjunction with rubber tree (*Hevea brasiliensis*). The potential production of this fruit in the area is approximately 100 t, distributed in two or three harvests per year. During the last three years arazá has been introduced in the local markets through a promoting campaign to increase awareness with consumers. With the purpose of invigorating the commercialization and consumption in Colombia, arazá fruits were harvest green and ripe, with a field selection, followed by a treatment of 1-MCP (1000 nl L⁻¹) for 1 h at room temperature, 27±3°C. The fruit were then packed in plastic totes of 8 kg (treatment E1) or in corrugated board boxes (treatment E2). The fruit were brought to the laboratory and were stored at 12±1°C. The objective of this study was to identify the critical points of the commercialization of fresh arazá, according to the two used packages, and with the 1-MCP treatment.

Physiological characteristics and quality variables were evaluated during the 10 days duration of the distribution and commercialization chain. The corrugated board boxes reduced the mechanical damages in the fruit. Fruits in both packages reached 75% change to green/yellow in 10 days. However, the fruit losses were reduced by 32% with the corrugated boxes in comparison with conventional use of the plastic totes. The 1-MCP treatment in combination with this alternative box kept nutritional components (organic acids) and other attributes associated with quality for a longer time which is the reason why this was recommended for local marketing.

87

[h017 / b000](#)

Title Developing a small grower based organic pineapple export system

Author L. Brenes, B. Piedra, R. Blanco, D. Salazar, J. Linares and A. Rodríguez

Citation ISHS Acta Horticulturae 906:99-108.2011.

Keywords organic certification; *Ananas comosus*; rural development

Abstract

The Costa Rican Northern Region Agroindustrial Program (Programa Agroindustrial de la Zona Norte) - PROAGROIN - established in 1997, pursues the development of one of the poorest regions of Costa Rica through the promotion of a sustainable agricultural production. This area comprises 12,000 km² mainly represented by Holdridge's humid and very humid tropical forest. Predominant soils are Ultisols and Inceptisols, showing poor chemical fertility, low in bases, with pH ranging between 4 and 5.5, and severe phosphate deficiency. 9% of the Costa Rican economically active population lives in this area. The families that have joined PROAGROIN have an average of 5 members, and annual family income between US\$ 2500 and 8000 of which more than half originate in the farm. The small grower has been integrated as the main actor thanks to an approach that merges financial support, technical assistance, quality assurance and international marketing of value added products. The production of Fair Trade certified pineapple and its export to the North American and European markets has been one of the ways to promote this development with an average annual export of 1,400,000 boxes in 1000 containers (16-20 tons each). The production of not only Fair Trade and Global Gap certified pineapple but organic pineapple was foreseen in 2005 as the next tool for entering markets and promotion. The financial analysis showed it was economically viable and the first three years of implementation have proven its agronomical viability, with average yields of 65-70 t/ha. To date, the production of 102 ha has been financed through 14 months loans with a total investment of ₡ 1544 millions (Costarican colones,

equivalent to approximately US\$ 2.6 millions) with a projected profit, after financial and operation costs, between 5 and 30% of the amount invested. During the first year the main limiting factors at the field level were identified. The first factor was related to available nitrogen sources, their mineralization and their adequate synchronization with plant uptake, all needing to be further adjusted. The second factor identified was phytosanitary management, particularly regarding root rot and mealy bugs. The third limiting area identified was postharvest losses. All these areas are addressed through cooperation with university researchers, farmers and the private sector. In the case of postharvest management, the main market complaints focused on the presence of mold in the fruit peduncle cut. On-going research activities to address this issue include fruit sanitization, fruit waxing, peduncle postharvest treatment, and general cleaning and sanitization of equipment and storage areas. An important challenge is the search for postharvest management alternatives that need to be done taking into consideration the organic certification standards which limit the options. These standards include the national regulation, the USDA Final Rule (7CFR205) and the European Regulation 834/2007 and 889/2008. The use of natural products and other GRAS products shows great potential and deserves further investigation.

88

[h004 / b001](#)

Title Effect of 1-methylcyclopropene (1-MCP) on green life of banana fruits harvested one and two weeks passed the conventional harvest index

Author A. Vargas , M. González and A. Ureña-Padilla

Citation ISHS Acta Horticulturae 906:259-265.2011.

Keywords *Musa* AAA; postharvest; subgroup 'Cavendish'; harvest

Abstract

The effect of 1-MCP on “green” postharvest life of Banana (*Musa* AAA) fruits, subgroup ‘Cavendish’, was investigated. The evaluation started by cutting “hands” out of the stalk, after the fruits stayed for one or two weeks beyond (13 and 14 weeks after flowering) the common commercial harvest index based on size of the fruit. The fruits were subjected to immersion for 0, 10, 20, 30 and 40 µg/L of 1-MCP, introduced in a Banovac plastic bag and packed in 12.7 kg corrugated boxes. Temperature of the fruit was decreased gradually to final storage at 16°C. The evaluation of the “green” color of the fruits was conducted until the fruits reached level 3 in the common color table used for bananas or the Von Loesecke scale. The results showed differences for both groups of bananas, indicating that 1-MCP can retard the change in color of bananas. Moreover, there was a linear trend among the 1-MCP treatments confirming

highest effect with the highest concentration. The green color was prolonged further in fruits that were only left for one week past the common harvest index as compared to those that were kept for two weeks. These results show that the use of 1-MCP can be a useful tool for determining harvest dates in commercial operations.

89

[h017 / b006](#)

Title Effect of alternative coatings and waxes on postharvest quality and shelf life of pineapples (*Ananas comosus* 'md-2') grown in Costa Rica for export

Author D.A. Saborío and J.M. Fonseca

Citation ISHS Acta Horticulturae 906:245-251.2011.

Keywords color; pitting; shelf life; visual appearance

Abstract

Antitranspirants or coatings are commercially used for export pineapples as this treatment can potentially extend the visual quality appearance. However, few options are available that allow treatment for both conventional and organic pineapple fruits. In this work we evaluated the effect of Natralife[®], an olive oil/honeybee based coating-OMRI certified, Stafresh[®], a broadly used conventional wax and two antitranspirants based on natural ingredients produced in Costa Rica (Ecofrut[®] and Biogreen[®]) that can potentially be considered organic. Antitranspirant treatments of pineapples were applied with and without fungicide (Bayleton[®]). Treatments consisted of 24 pineapples per evaluation time. Evaluations were conducted after fruit were cold stored (7-9°C) for 14, 21 and 23 days, including 1-3 days exposure at room temperature. In general, on the first evaluation fruit showed similar quality characteristics. Other results showed that pineapples treated with Natralife[®], with or without fungicide, had the lowest weight loss. On the second evaluation while Natralife[®] treated-fruit had 3.18% of weight loss, Stafresh[®]-treated fruits (with fungicide) had 3.72% weight loss. In external color, Natralife[®] (second evaluation) and Natralife[®] with fungicide (second and third evaluation) showed the highest values. The translucence (development of internal color) of Natralife[®]-treated fruits was lower than that of most treatments in the second evaluation, while Biogreen[®], Stafresh[®] and the untreated control showed the highest values. Both Stafresh[®] and Natralife[®] with fungicide showed lower values of mold development on the stem base, indicating a significant effect of the fungicide on this parameter. Overall, in all evaluations Natralife[®] treatments significantly reduced the incidence and severity of fruit pitting, subsequently showing higher overall visual appearance.

90 [g040 / b006](#)

Title Effect of basal thermal treatments on the postharvest quality and shelf-life of calla lily (*Zantedeschia aethiopica*)

Author S. Lazzereschi, B. Nesi, G. Burchi and A. Grassotti

Citation ISHS Acta Horticulturae 906:275-280.2011.

Keywords flower longevity; ornamental rhizome; cut flowers; winter heating; summer cooling; production time

Abstract

Calla lily (*Zantedeschia aethiopica*) has become one of the most popular cut flowers worldwide for its ornamental characteristics of the spathe. *Z. aethiopica* reaches full bloom in spring with a drastic reduction from summer to winter as a result of excessively high or low temperatures, respectively, in the root zone. In an attempt to extend production time, to improve flower longevity and postharvest quality, the effects of the following thermal treatments applied to the root zone were evaluated: (1) only heating in winter, (2) only cooling in summer, (3) both heating in winter and cooling in summer, and (4) no thermal treatments (control). Plants were cultivated in plastic containers in a greenhouse at CRA-VIV, Pescia, Italy, using a growing medium composed of 34% expanded clay and 66% peat in volume. Planting density was 4 rhizomes m². Temperature treatments were applied using corrugated tubes through a basal distribution system placed under the containers. The cooling treatment was from June to September 2008 and the heating treatment from October 2008 to March 2009. Flowers were harvested in three different production periods: August to September, October to November, and December to January. Postharvest vase-life and quality attributes including length and weight of stems and length of the spathe were evaluated. Stems showed a significant improvement of flower longevity following cooling in summer and heating in winter. Both cooling and heating in all seasons increased vase life about 6 days compared to controls. Other quality parameters, such as stem length and weight, were significantly improved. Spathe length was not affected by thermal treatments.

91 [f011 / b000](#)

Title The development of physicochemical, microbiological and nutritional parameters of broccoli (*Brassica oleracea* var. *Italica*) under simulated postharvest conditions in Bogota, Colombia

Author Y. Piñeros-Castro, L. Serrato, D. Rodríguez and L. Rincón

Citation ISHS Acta Horticulturae 906:183-188.2011.

Keywords phenolics; antioxidant activity; sanitation

Abstract

Broccoli (*Brassica oleracea* var. *italica*) is a very perishable vegetable. Postharvest losses of broccoli occur due to water loss, yellow coloration, mechanical damage, separation of flowers and rotteness. Broccoli is recognized as an important source of vitamins, minerals and anticarcinogenic compounds which has motivated its increased demand. However, the short shelf life is limiting the potential expansion in the market of developing countries, where postharvest losses are considerable. In this work we studied physicochemical, microbiological and nutritional quality parameters of broccoli (*Brassica oleracea* var. *italica*) after treatments with chlorine dioxide (3 mg/L) and with ozone (0.34 mg/L) under postharvest conditions that simulated commercial handling in the Sabana of Bogota, Colombia. Decrease of acidity and Brix was observed during storage. Phenolics increased, with a maximum value of 20 mg galic acid/100 g of broccoli by the end of the experiment. However, neither phenolic content nor antioxidant activity was found different among treatments. The population of molds and yeasts declined after the treatments, by 0.59 log with chlorine dioxide and by 1.02 log with ozone. Molds and yeasts were reduced until the 6th day of the experiment in the treated materials, while no difference was found later in the trial. It can be concluded that the use of chlorine dioxide and ozone favors microbiological quality of broccoli handled under conditions prevalent in the Sabana of Bogota, Colombia, only during early stages of the postharvest storage.

92 [f006 / b003](#)

Title Effect of chlorine dioxide and ozone on physicochemical, microbiological and nutritional parameters of iceberg lettuce (*Lactuca sativa* var. *Capitata*) in simulated postharvest handling in the Bogota Sabana, Colombia

Author L. Serrato, L. Rincón and Y. Piñeros-Castro

Citation ISHS Acta Horticulturae 906:177-182.2011.

Keywords postharvest lettuce; phenolics; antioxidant activity; disinfection

Abstract

The iceberg lettuce (*Lactuca sativa* var. *capitata*) suffers fast postharvest deterioration due to the presence of microorganisms, reactions of enzymes, inappropriate handling, among others. In this context, postharvest treatments are necessary to avoid the fast deterioration of these vegetables, extend shelf life and decrease the amount of losses. In Colombia, currently there is no suitable protocol for postharvest handling of lettuce cultivar 'Batavia', which prevents producers from assuring high product quality. It is thought that postharvest losses of lettuce can reach values ranging from 20 to 30%. Lettuce is considered of value due to its freshness and its high content of water, in addition, lettuce is a low energetic food. Furthermore, lettuce has minerals, fiber and substances with antioxidant and anticarcinogenic properties. Nevertheless, lettuce can represent a potential danger for human health because it may carry clinical pathogens. This work allows to determine changes in nutritional and microbiological parameters of iceberg lettuce (*Lactuca sativa* var. *capitata*), when applying treatments of chlorine dioxide (ClO₂) and ozone (O₃), two common disinfection treatments. In this work the physico-chemical (acidity, soluble solids) and functional (phenolics and antioxidant activity) characteristics were measured, as well as native microbial population (aerobic) under simulated transportation: 67% HR, 18°C, 12 h (transport from harvest site to cold storage, treatment and packing house); 85% RH, 24 h storage at 10°C (waiting time in distribution center), 11 d at 3°C (shipping) and 6 d at 6°C (storage at retail shelf), simulating the conditions of post-harvest management at the Sabana de Bogotá. The vegetable material was subjected to various disinfection treatments including dioxide concentrations at 3 ppm, ozone at 0.34 ppm, and water (control) for 30 s. The results showed a significant reduction (1,17 log) that can be achieved, in 6 h after treatment with any of the two sanitizers. Moreover, an increase in phenolic compounds in treated lettuces was observed, subsequently increasing the antioxidant activity. It is possible to conclude that using chlorine dioxide and ozone as disinfectant treatments improves nutritional quality, while reduce microbial content in 'Batavia' lettuce grown in the Sabana of Bogota, Colombia.

93

[g012 / b000](#)

Title Effect of leaf treatments on flower quality and shelf life in Asiatic lily

Author G. Burchi, D. Prisa, A. Ballarin and A. Grassotti

Citation ISHS Acta Horticulturae 906:19-24.2011.

Keywords *Lilium* spp.; postharvest quality; flower longevity; flower color

Abstract

Lily (*Lilium* spp.) is one of the most important cut flower species on the international market. It ranks 5th after rose, tulip, spray chrysanthemum and gerbera for total sales at the flower market of Aalsmeer. The improvement and conservation of flower quality attributes during postharvest management is a very important target in the flower industry. Previous small plot trials carried out at the experimental farm of CRA-VIV Pescia (Italy) showed the positive effects of pre-harvest leaf treatments with sugars, salts and antioxidant compounds on postharvest quality (flower size and color, inflorescence height and longevity) in Asiatic and Oriental Lily. In forward studies, the effects of leaf treatments were evaluated on large scale experiments carried out in a commercial nursery as explained in this article. Two Asiatic cultivar ('Fangio' and 'Cavalese') were grown in different rows in the same greenhouse. Treatments applied were: vitamin C (2 g/L); citric acid (1 g/L); sucrose (2 g/L); K₂SO₄ (2 g/L). Application of sucrose and K₂SO₄ confirmed the positive effects of leaf treatments on stem height, tepal length, tepal color, and inflorescence vase life obtained in previous small plot trials. Also application of antioxidant compounds, such as vitamin C and citric acid, improved postharvest quality attributes in both cultivars: in particular, citric acid significantly improved stem height and diameter and vase life in 'Cavalese' and vase life in 'Fangio'; vitamin C significantly improved stem height in 'Cavalese' and vase life in both cultivars. Moreover, the treatments with antioxidant compounds improved tepal color quality. These trials, carried out in a commercial nursery, demonstrate that growers can use these simple and inexpensive treatments to improve important qualitative traits in Asiatic lily.

94

[h004 / b000](#)

Title Efficacy of plant extracts on growth reduction of *Colletotrichum musae* and *Fusarium proliferatum*, causal agents of crown rot of bananas

Author G. Umaña-Rojas and J. García

Citation ISHS Acta Horticulturae 906:205-210.2011.

Keywords crown rot; banana; aqueous plant extracts; *Colletotrichum musae*; *Fusarium proliferatum*; eucalyptus

Abstract

Aqueous extracts from plants commonly used in medicine, food, or that traditionally have been associated with some antifungal effect, were tested against *Colletotrichum musae* and *Fusarium proliferatum*, two of the main fungi causing banana crown rot (PCB). Extracts of *Gliricidia sepium* and *Eucalyptus globulus* were the most effective to reduce colony growth and lesion depth in banana fingers

inoculated with *C. musae*. Extracts of *Thymus vulgaris* and *Allium sativum* reduced colony growth of *F. proliferatum*. The most effective extracts for reducing lesion development were *E. globulus*, *Neurolaena lobata* and *T. vulgaris*. *E. globulus* was active in vivo for both *C. musae* and *F. proliferatum*. There were less extracts with inhibitory activity in vitro for *F. proliferatum* and the results obtained in vitro and in vivo differed. For *C. musae* the results obtained in vitro and in vivo were similar.

95 [h004 / b000](#)

Title Frequency of organisms associated with crown rot of bananas in integrated and organic production systems

Author G. Umaña-Rojas and J. García

Citation ISHS Acta Horticulturae 906:211-217.2011.

Keywords crown rot; banana; production systems; *Fusarium* species; *Erwinia*; *Pseudomonas*; *Fusarium proliferatum*; *Fusarium semitectum*

Abstract

The frequency of organisms associated with crown rot of banana (PCB) in Costa Rica was compared in two banana production systems. The organisms isolated were similar to those previously described by other authors and were common to the two systems (integrated and organic), but the frequency of recovery, overall, was higher in the integrated system. Organisms more frequently found in the integrated production system were *Erwinia* spp., *Pseudomonas fluorescens*, *Fusarium proliferatum*, *F. semitectum*, *F. graminearum*, other species of *Fusarium*, *Lasiodiplodia theobromae*, *F. verticillioides*, *F. sacchari*, yeasts and fungi that did not sporulate. In organic farming the highest percentage of fungi isolated were *F. subglutinans*, *Acremonium* sp. and *Colletotrichum musae*. *F. verticillioides* was only recovered in the integrated system.

96 [h004 / b000](#)

Title Incorporation of organic fungicides in conventional packing process of banana (*Musaaaa* 'Williams')

Author C. Demerutis and L. Quirós

Citation ISHS Acta Horticulturae 906:171-176.2011.

Keywords banana; postharvest diseases; organic treatments; Biocto; Verdiol

Abstract

One of the main problems that the banana agro-industry faces in Costa Rica is the control of postharvest diseases. Molds are among the main agents that cause fruit rotting during transportation in refrigerated containers. The most widely used postharvest conventional treatment to prevent fungi and molds damages in banana, is the application of thiabendazole during the packing process. The increasing world-wide demand for fresh, healthy and safe products has created international standards of security for the exported fresh fruits that allow product traceability and pesticide reduction. Studies and own commercial experience by EARTH University show that the use of Biocto and Verdiol is a possible organic commercial alternative for postharvest disease control in banana. The purpose of the present work is to give the basic criteria to modify the conventional packing operations, when the use of chemical fungicides is replaced by organic ones, to maximize storage life for banana in a transitional packing process.

97 [g048 / b000](#)

Title Induction of ethylene insensitivity into *Oncidium* and *Odontoglossum* orchid species for improvement of display life

Author B. Raffener, M. Serek and T. Winkelmann

Citation ISHS Acta Horticulturae 906:253-257.2011.

Keywords 1-methylcyclopropene; display life; flower senescence; postharvest quality

Abstract

Two orchid species, *Oncidium* and *Odontoglossum*, are sensitive to ethylene. Exposure of cut inflorescences or potted flowering plants to $1 \mu\text{l L}^{-1}$ of ethylene accelerated bud drop, wilting of florets, and yellowing of leaves and pedicels. To prevent ethylene effects two strategies have been used in our studies: 1) treatment with the ethylene receptor blocker 1-methylcyclopropene (1-MCP), 2) *Agrobacterium* mediated transformation with an *etr1-1* mutant gene from *Arabidopsis thaliana*. Selected cultivars of *Oncidium* and *Odontoglossum* orchids were pre-treated with 200 nl L^{-1} 1-MCP at 20°C for 6 h and subsequently exposed to 0 or $1 \mu\text{l L}^{-1}$ ethylene. 1-MCP clearly improved postharvest characteristics of both investigated species as well in presence as in the absence of ethylene.

98 [h010 / b001; b006](#)

Title Influence of fruit maturation, modified atmosphere packaging and storage temperature on physico-chemical quality attributes of fresh-cut West Indian lime (*Citrus aurantifolia*)

Author M. Mohammed and L.D. Wickham

Citation ISHS Acta Horticulturae 906:67-72.2011.

Keywords fruit quality; maturation; ripening; chilling injury; storage; packaging

Abstract

West Indian lime fruit (*Citrus aurantifolia*) at the mature-green (M1) and ripe-yellow (M2) stages of maturity were sliced into quarter sections, seal-packaged in low density polyethylene bags (LDPE), stored at 4-5°C, 7-8°C and 28-30°C and evaluated daily up to seven (7) days for marketable quality, cut-edge browning, chilling injury, fermentative aroma, pH, total soluble solids (TSS), total titratable acidity (TTA), TSS:TTA and vitamin C content. Storage temperature and fruit maturity noticeably influenced post-cutting quality and shelf-life. The best overall treatment was attributed to ripe-yellow (M2) fruit quarter slices stored at 7-8°C. The superior marketable quality of these slices resulted from absence of chilling injury symptoms, cut-edge browning and fermentative aroma that was typical of those slices, at the same stage of maturity, held at 4-5°C from day four (4) onwards. At 28-30°C quarter sliced lime fruit at both stages of maturity became unmarketable in less than two (2) days. The post-cutting life and quality of mature-green (M1) quarter slices succumbed to chilling injury damage after one (1) day at 4-5°C and after five (5) days at 7-8°C. Ripe-yellow (M2) quarter slices, which were less sensitive to chilling injury than their mature-green (M1) counterparts, exhibited no chilling injury symptoms at 7-8°C and only slight symptoms at 4-5°C after seven (7) days of storage.

99 [h004 / b000](#)

Title Influence of production system and weather variables in the incidence and severity of crown rot in bananas

Author G. Umaña-Rojas, J. García and L.F. Arauz

Citation ISHS Acta Horticulturae 906:197-204.2011.

Keywords integrated production systems; organic farms; weather variables

Abstract

Crown rot of banana (CRB) is the most important postharvest disease of banana fruits. In order to understand the influence of production systems and weather parameters on the development of CRB three farms with integrated production systems, and three organic farms located in the Caribbean region of Costa Rica, were selected and sampled every two weeks for a year. Results showed lower presence of CRB in the organic system than in the integrated system. The highest incidence occurred in periods of high precipitation and high relative humidity. Moreover, these weather variables correlated with an increase in CRB in the integrated production system farms. Increased frequency of rainfall, particularly exceeding 100 mm, correlated with increased CRB in the organic system farms. Regression analysis showed that incidence of CRB was associated with the type of system (integrated/organic), the cumulative average temperature, the highest accumulated temperature, the interaction between average cumulative temperature and days with rain, and with number of days with rainfall events. As the number of days with precipitation events increased and the average temperature increased, there was a decline of CRB. However, after 67 consecutive days with rainfall events, increased temperature produced increased CRB. This model explained 35% of variability observed in incidence of CRB and 38% of variability of severity.

100 [f999; h999 / b007](#)

Title Little-known tropical fruits: use and perspectives

Author M.S. Hernández-Gómez

Citation ISHS Acta Horticulturae 906:109-113.2011.

Keywords native; indigenous; promotion; Amazonian; underutilized fruit; Andean; neglected crops

Abstract

Tropics offer a great variety of fruit and vegetable species. Although, all of them exhibit nutritional, organoleptic or functional attributes required to be included in market chains, only few are usually consumed. Others continue underused or even unknown. Some issues could be responsible for this situation: accessibility to the resources, wild abundance, distribution of the specie, lack of information of benefits, traditional consumption uses, low production, make part of the bottleneck. Nowadays the list of tropical underused species increases and some preliminary research results demonstrate their importance for many purposes. There is not a unique strategy to solve this uneven situation for tropical less used fruit but multiple actions could be developed for these new species to get a new status among the fresh or processed products. In Colombia, many underused fruits from the *Myrtaceae*, *Passifloraceae*, *Palmaceae* or *Solanaceae* family among others are identified as promising fruits for local or international market.

Arazá, camu camu, cocona, purple passion fruit and asaí are new dessert or processed fruits names for consumers. Though, many years have been necessary to include some of them in local markets, research results in national institutions and experiences of local growers can be taken into account to enhance unexploited fruit uses in similar conditions, in other countries. The international market could be another challenge because of standards result of its exigencies and supportive information requirements. A strong network based on research and growers' experience exchange could improve successful results in getting on the international markets.

101

f008 / b000

Title Modifications in tomato fruit ripening alter susceptibility to the pathogenic fungus *Botrytis cinerea*

Author B. Blanco, D. Cantu, A.B. Bennett, J.M. Labavitch, A.L.T. Powell and Hong Wang

Citation ISHS Acta Horticulturae 906:161-170.2011.

Keywords tomato ripening mutants; ripening regulation; gray mold; fungal infection; qRT-PCR

Abstract

During ripening, fleshy fruit undergo biochemical and physiological changes that result in the organoleptic and nutritional qualities used to market the ripe fruit as consumable post-harvest products. However, some ripening processes, such as textural changes, contribute to the enhanced susceptibility of ripe fruit to pathogens. Ripe tomato fruit are particularly susceptible to fungal pathogens, such as the ascomycete, *Botrytis cinerea*. Before the onset of ripening, tomato fruit are highly tolerant of *Botrytis* infections, whereas ripe fruit are extremely susceptible. Investigating the ripening-associated increased susceptibility of tomato fruit to *B. cinerea* provides novel insights for understanding plant-fungus interactions and eventually may lead to the development of efficient methods to control infections in perishable products. The molecular and genetic basis of plant-*Botrytis* interactions has been described for tomato leaves but our understanding of the role played by fruit ripening in susceptibility to infection has been limited. We have evaluated the susceptibility to *Botrytis* of the tomato fruit ripening mutants, *rin*, *nor* and *Nr*. The absence or the modification of ripening in these mutant fruit results in differences in susceptibility and altered activation of responses to fungal infection. Our results suggest that only some aspects of ripening make fruit susceptible and that organ-specific developmental processes are important contributors to susceptibility. Characterization of the specific ripening events that promote susceptibility

will facilitate the development of commodities that ripen acceptably and yet are less susceptible to fungal infections.

102 [f004 / b000](#)

Title Onion storage data from Zimbabwe: a statistical method to demonstrate end of dormancy and the onset of sprouting

Author N.D. Hyde, J.E. Reeves and L. Currah

Citation ISHS Acta Horticulturae 906:49-54.2011.

Keywords *Allium cepa*; high temperature storage; cultivar differences; statistics

Abstract

Onions in the tropics and subtropics are often stored under ambient conditions. In 1990-1991, onions grown at Marondera, Zimbabwe under drought conditions were stored under cover on wire shelving in a naturally ventilated store and the change of weight loss was measured in a replicated trial until all the onions were sprouted or decayed. Data sets from 27 cultivars in the Zimbabwe trials were studied in a statistics dissertation in the UK and indicated that there was a distinct change in the slope of the line indicating percentage weight loss during the trial. An early, shallow slope indicated normal physiological weight loss of about 1 to 4% per week, and then there was a distinct change to a second, steeper slope showing a more rapid weight loss after the bulbs emerged from dormancy and started to re-sprout internally. The second rate ranged between 4 and 10% decline per week. The date of the point of change of the slope can be used to compare cultivars for their storage potential and to group them for storage quality. In other years that were less dry, there was more interference from storage diseases and the same clear pattern did not occur.

103 [h001; h004 / b005](#)

Title Packaging engineering for tropical horticultural products: geometric, structural and thermal optimization of mango and banana packages

Author B.J.M. Teruel, R. Funes Abrahão and F. Zalazar Chacón

Citation ISHS Acta Horticulturae 906:137-146.2011.

Keywords *Musa cavendishii*; *Mangifera indica* L.; cooling time; effective opening areas; structural strength; design; computer simulation

Abstract

Fruit and vegetable production has been growing significantly every year, in Brazil and worldwide. Therefore, the application of appropriate technologies requires constant improvement and technological investment, from harvest to commercialization. Particularly, packages are a significant part of post-harvest losses statistics for fresh fruit and vegetables; only 10 to 50% from the total yield are reported per year, depending on the country's development, climate, cold chain employment, logistical aspects, and others. This study introduces the methodology of a packaging design project and discusses results of its application for design and optimization of mango (*Mangifera indica* L., 'Tommy Atkins') and banana (*Musa cavendishii* 'Nanica') packages, based on computer simulation and experimental validation. It was aimed to minimize material volume (reforestation wood - *Pinnus ellioiti*) by combining structural, thermal, ergonomic and geometric aspects, as effective areas and opening distribution. The Finite Element Method (FEM) was employed for optimization and structural dimensioning, allowing a material volume reduction of 83% for banana package and 67% for mango package. Due to the effective opening area distribution, the cooling time reduction of fruit, which were cooled by forced-air, was on average 50% as for packaging commercially utilized. The results of this study, as well as the methodology applied, may be employed for commercial purposes, such as for reforestation wood packages, provided these are watertight and non-reutilized, even for export markets. The methodology used combined computer and engineering tools, at an appropriate cost-benefit relationship among structural, geometric, thermal and ergonomic aspects.

104 h004 / b000

Title Pathogenicity of organisms associated with banana crown rot in two banana cultivars

Author G. Umaña-Rojas and J. García

Citation ISHS Acta Horticulturae 906:219-223.2011.

Keywords crown rot; banana; integrated production systems; organic farms; isolated; 'Gros Michel'; 'Cavendish'; *Fusarium* species; pathogenicity

Abstract

Pathogenicity tests were conducted for ten organisms associated with crown rot of banana (CRB) in organic and integrated banana production systems in Costa Rica. Pathogenicity was tested on two banana cultivars. On cultivar 'Cavendish', the most aggressive fungi were *Fusarium verticilloides*, *F. subglutinans*, *F. proliferatum* and *F. sacchari*. On 'Gros Michel', the most aggressive were *F.*

verticilloides, *F. semitectum*, *F. sacchari*, *F. graminearum*. Overall, 'Gros Michel' was more susceptible to these organisms than 'Cavendish'.

105

[h999 / b007](#)

Title Postharvest technology of tropical export produce: recent developments and challenges of a future free-trade world market

Author S.K. Mitra, I. Chakraborty and P.K. Pathak

Citation ISHS Acta Horticulturae 906:115-123.2011.

Keywords fruits; subtropical; food security; supply chain

Abstract

Tropical and subtropical fruits present special problems in conservation and transportation because they are much more perishable than temperate tree fruit and because of the long distances between the producing countries and their major export markets. Most of the tropical fruits tend to be climacteric, and as such very susceptible to the ripening effects of the naturally occurring gaseous hormone ethylene that promote texture change and softening, conversion of starch to soluble sugars, induction of aroma and flavour compounds and the promotion of additional ethylene synthesis. Considerable success has been obtained in the control of ethylene biosynthesis and action, using specific chemicals that target particular biochemical reaction. Biotechnology has the potential to influence many genes involved in ripening, including those concerned with ethylene synthesis and action, taste and flavour and resistance to postharvest pathogens. Most tropical fruits have a postharvest life of only a few weeks at the most. Modified (MA) and controlled atmospheres (CA) have been shown to ameliorate chilling sensitivity. Prolonged postharvest life for export to distant markets requires adequate postharvest handling systems, such as optimum harvesting time, control of insect and diseases, and the use of ideal postharvest temperature management. MA and CA can be of major benefit to preserve the quality of these fruits and to prolong their postharvest life. The establishment of both Sanitary and Phytosanitary (SPS) agreement and Technical Barrier to Trade (TBT) under GATT was to facilitate trade and avoid unjustified restrictions on trade. However, to date the export of fresh fruits from tropical and subtropical countries still faces problems in gaining market access in some countries especially the developed countries. Non tariff protectionism will play an increasing role in the future. Therefore biosecurity issues (quarantine pests and diseases) will become more stringent in many countries even when there is limited if any scientific reason for imports. Carbon footprints (or food miles) will be one form of non-tariff barrier used

in some countries (especially in Europe) and this will clearly impact on growers of tropical fruit. More research on tropical fruits has to be carried out to gather scientific information in order to comply with the phytosanitary measures of the importing countries. The application of technology to tropical and subtropical fruits has seen dramatic changes over the last 20 years. These changes have been driven by consumer demands for excellence and wholesomeness. Delivering high quality produce to consumers is a key postharvest goal. Development of appropriate vertically integrated supply chains for tropical fruits will need to be improved if industries in developing countries are to succeed. This will require greater cooperation between private companies and public institutions at all levels of the chain.

106 h010 / b000

Title Preharvest mango (*Mangifera indica* L. 'Apple') fruit bagging controls lenticel discolouration and improves postharvest quality

Author F.M. Mathooko, E.M. Kahangi, J.M. Runkuab, C.A. Onyangob and W.O. Owinob

Citation ISHS Acta Horticulturae 906:55-62.2011.

Keywords fruit bagging; fruit quality; *Mangifera indica*; mango; ripening; sensory evaluation

Abstract

Fruit bagging during growth is practiced on some fruit crops in Australia and Japan to control damage by physiological and pathological disorders. This study was undertaken to investigate whether this treatment could be used to control lenticels discoloration, a physiological disorder unique to 'Apple' mango, a popular cultivar in Kenya, which has a high demand in both domestic and export markets. 'Apple' mango fruit were bagged at 70 days after bloom (DAB). Bagged and unbagged fruit were harvested at 168 DAB, subjected to quality analysis at harvest and on regular intervals during ripening. The experiment was set on a completely randomized design and means subjected to a t-test for comparison and least significant difference for separation at $p < 0.05$. There were no significant differences ($p > 0.05$) in fruit weight and diameter between bagged and unbagged fruit. However, bagged fruit had significantly ($p < 0.05$) higher peel hue angle (H°) and L^* values. Sensory analysis rated bagged fruit superior in terms of appearance, color and overall acceptance at harvest and on ripening. There were no significant differences ($p < 0.05$) in taste and flavor between bagged and unbagged fruit. Bagged fruit had a prolonged postharvest life and reduced weight loss, and this may be of economic importance to the mango fruit retailers. These results indicate that bagging may produce an unblemished, attractive and high quality fruit at harvest and on ripening, leading to improved exports and better prices for mango fruit farmers.

107 [h057 / b006](#)

Title Prolonging postharvest quality of camu camu (*Myrciaria dubia* H.B.K.) as the first step in the commercial chain

Author M.P. Carrillo, M.S. Hernández, J.E.C. Cardona, J. Barrera, O. Martínez and J.P. Fernández-Trujillo

Citation ISHS Acta Horticulturae 906:31-36.2011.

Keywords refrigeration; maturity stage; fruit quality; shelf life; color; respiration; weight loss

Abstract

Camu camu (*Myrciaria dubia* H.B.K.) is a shrub present in flooded zones of the Amazonian. The fruits of this plant have a high nutritional content, notably due to the high levels of vitamin C and other antioxidants. To assure utilization of the fruit it is key to identify the optimal handling and storage conditions. This study aimed to optimize the commercialization chain of camu camu, with the support of the Lumber Association of Tarapacá and the women association of Tarapacá. Camu camu fruits with turning color and fully ripe color were harvested in Tarapacá (Amazonas-Colombia) and transported via air to Bogotá. The fruit in both maturity stages (turning color and fully ripe) were stored at (6, 10 and 20°C, all at 85% relative humidity), evaluating its physiological behavior and quality for 4 days (fully ripe) and 8 days (turning color). The fruit was found to have a climacteric pattern. For both maturity stages, the lower temperature (6°C) preserved for longer time the vitamin C and the retention of color, as well as reducing weight loss and respiration rate. However, at this low temperature fruits showed chilling injury. It was observed that a fruit at the turning color and storage at 10°C, the shelf life is extended and the retention of nutrients is prolonged (vitamin C and sugars).

108 [h999 / b005](#)

Title Quality changes in balata (*Manilkara bidentata*) fruit as affected by modified atmosphere packaging during refrigerated storage

Author M. Mohammed and L.D. Wickham

Citation ISHS Acta Horticulturae 906:63-66.2011.

Keywords storage; modified atmosphere packaging; fresh weight losses; total soluble solids

Abstract

Quality changes of balata (*Manilkara bidentata*) were investigated by storing fruits in low density polyethylene bags (LDPE) and in paper bags (PB) up to 7 days at 6-7°C. The dark orange yellow, glossy skin colour with L, a, b values of 51.7, 9.9, 36.3 changed after 7 days under refrigerated conditions to 32.6, 21.1, 18.9 for fruits kept in PB and to 36.1, 23.3, 21.1 for fruits held in modified atmosphere storage in sealed LDPE bags. Likewise, the light creamy-brown flesh changed from an initial L, a, b reading of 53.2, 2.3, 27.1 to 47.5, 1.7, 15.4 for control fruit and to 45.5, 1.7, 13.4 for sealed LDPE fruit. The modified atmosphere created within the sealed LDPE bags effectively controlled fresh weight losses to only 0.13% compared to 6.2% for fruit in paper bags over the entire 7 days at 6-7°C. In addition, fruit kept in LDPE bags attained higher total soluble solids (TSS), pH, TSS:TTA and vitamin C retention compared to their counterparts in PB. Fruit in LDPE bags maintained their glossy appearance and had a more acceptable taste and flavor than fruit stored in PBs. Generally, balata fruit with a mean fruit weight ranging from 9.06 to 13.18 g have a juicy, sweet tasting flesh that accounts for 43% of the fruit weight. The remainder of the fruit is made up of inedible skin (34.8%) and seed (22.2%).

109

f028 / b000

Title Quality changes of 12 commercial hybrids of carrots during storage
Author F. Richmond, C.H. Méndez and G. Umaña-Rojas
Citation ISHS Acta Horticulturae 906:73-82.2011.
Keywords Brix; color; postharvest; roots; deterioration; cultivars

Abstract

Postharvest quality variables of 12 commercial carrot hybrids were evaluated. The hybrids were: 'Bangor F1', 'Nandrin F1', 'Napoli F1' and 'Norwich F1' from Bejo; 'Big Sur' and 'Sirkana' from Nunhems; 'Bolero F1' and 'Concerto F1' (VAC 03 F1) from Vilmorin; 'XCR3688' and 'S-505' from Sakata; 'Esperanza' and 'Dulce' from Seminis. A standard treatment was applied to all the carrots, including mechanical rinsing and scrubbing the roots with water and Kilol (product based on citric extracts with bactericidal effect, at 0.05 ml/L) right after harvest, followed by hydrocooling at 2°C and cold storage for 56 d at the same temperature. Two groups were formed from each hybrid. The first group was subjected weekly to quality variables including color, firmness, ratio xylem/phloem, soluble solids content (°Brix). The second group was also evaluated weekly, on color, weight loss and incidence of decay. Three different types of decays were found: physiological damage, pathogen induced, and others

found without identifying any casual agent. There was no difference among the hybrids with respect to water loss. In color, only 'Big Sur' and 'Esperazon' were different from the rest. 'XCR3688' and 'Bolero F1' were firmer, while 'Bolero F1' showed the highest Brix. 'Dulce' and 'S-505' had reduced amount of postharvest deterioration. In conclusion the hybrids that best performed in postharvest storage were: 'Dulce', 'S-505', 'Sirkana', 'Bolero F1', 'XCR3688', 'Big Sur', 'Esperanza' and 'Bangor F1'.

110 [h999 / b000](#)

Title Quality, bioactive compounds and antioxidant activity of cashew apples from precocious dwarf cashew clones CCP-09, CCP-76 and BRS-189

Author A.C.S. Pereira, C.M. Reges, I.S. Reges, M.S.M. Rufino, R.E. Alves, M.F.G. Silva and C.F.H. Moura

Citation ISHS Acta Horticulturae 906:43-48.2011.

Keywords cashew; characterization; functional compounds

Abstract

Brazil is one of the world's largest producers of tropical fruit and is a major exporter of cashew nuts (*Anacardium occidentale*). The cashew fruit consists of two parts: the true fruit (cashew nut) and the false fruit (cashew apple or peduncle). The latter is marketed in natura or processed into juice, sweets and ice-cream, among others. Recently published studies have confirmed the health benefits of fruit consumption, particularly fruits with high levels of bioactive compounds and antioxidant activity. The objective of this study was to evaluate the quality, bioactive compounds and antioxidant activity of cashew apples from commercially available precocious dwarf clones (CCP-09, CCP-76 and BRS-189) developed by Embrapa Tropical Agroindustry (Fortaleza, Brazil). The fruit was weighed (nut, apple and total weight) and the apples were evaluated for color, diameter, length, firmness, soluble solids (SS), total soluble sugars, reducing sugars, total titratable acidity (TTA), pH, SS/TTA, total pectin, flavonoids, anthocyanins, carotenoids, total extractable polyphenols and antioxidant activity (by the ABTS method). Weighing over 120 g on the average, CCP-76 and BRS-189 may be regarded as commercially valuable cashew apples (type 4 or 5). BRS-189 is distinguished by its bright red color and high levels of bioactive compounds (vitamin C, anthocyanins, flavonoids, carotenoids and polyphenols) and total antioxidant activity.

111 [f057 / b003](#)

Title Revisiting the use of electrolyzed water as a fresh produce sanitizer
Author R. Yudin, M. Zuñiga and J. Vergara
Citation ISHS Acta Horticulturae 906:225-234.2011.
Keywords *Cucumis melo* var. *cantalupensis*; cantaloupe melon; *Salmonella*; mixed oxidants; activated water; electrolyzed oxidizing water

Abstract

Food-borne disease outbreaks, linked to minimally processed fresh produce, have increased pressure on growers, packers and processors to ensure a minimal pathogen presence. Traditional sanitation procedures are not achieving consistent microbial control, leading to research into novel methods; one of these is “electrolyzed water”, (EW) one of several names for the chlorinated liquid produced by closed-cell electrolysis of a dilute sodium chloride solution. Earlier published reports indicate that acidic EW made with primitive technology is an effective produce sanitizer. More elaborate recent reactors can produce a neutral chlorinated liquid (NEW) of much higher sanitizing power. Some initial small-scale experiments show that this material has considerable potential in the horticultural industry.

112 [f006 / b003](#)

Title Scrutinizing the sanitizing process involving aqueous chlorine from field to fresh-cut iceberg lettuce
Author S.D. Fallon, D.V. Rios and J.M. Fonseca
Citation ISHS Acta Horticulturae 906:37-41.2011.
Keywords chlorine; contamination; peroxyacetic acid

Abstract

The most commonly used sanitizers for numerous procedures in the postharvest industry are chlorine based. However, the impact this sanitizer has on the reduction of pathogenic microorganisms differs depending on the microorganism and produce in question, although it is generally limited to a 1-2 log reduction, when using concentrations permitted for produce. An investigation of the impact of aqueous chlorine sanitization on generic *E. coli* during postharvest and fresh-cut processing of iceberg lettuce was conducted at The University of Arizona, Yuma Agricultural Center, USA. Common commercial practices were simulated using a high bacterial load (10^8 cfu/ml) culture to contaminate a harvesting tool to assess

the number of heads affected from one contamination and the effectiveness of approved sanitizers. Results showed that as many as 75 heads of lettuce could be contaminated with the continued use of a contaminated harvest tool quitar used to core the heads. The concentration of bacterial contamination is reduced if the cored region is sprayed with a sanitizer immediately after coring. While using water alone on the cored region produced 10^5 cfu/g, using either chlorine or peroxyacetic acid (PAA) showed only a decrease to 10^4 cfu/g. The use of the sanitizers in different frequency and in combination as an alternative to the common triple treatment with chlorine, showed the latter as the treatment with the most effective reduction on generic *E. coli*. The level of reduction was still insufficient to ensure the safety of the lettuce if a high microbial contamination were to occur. This work reveals the high risks associated with the lack of a continuous system for decontaminating harvesting tools and equipment, and highlights the need for further research to identify a better multiple-rinse sanitation system, than the predominant chlorine washes and the emerging approved alternatives.

113 [h999 / b007](#)

Title Supply chain challenges for minor tropical fruit: the Dabai example

Author Lau Cheng Yuon and E.W. Hewett

Citation ISHS Acta Horticulturae 906:147-152.2011.

Keywords *Canarium odontophyllum*; fruit quality; tree management; cultivar improvement; storage; freezing; processing; packaging; marketing; R&D

Abstract

Sarawak has a rich gene pool of indigenous fruit trees with potential to be commercialized. International efforts exist to conserve and promote diversity in food supplies for human kind, and development of new fruit for national and international markets is a challenge for local scientists and growers. The Dabai fruit (*Canarium odontophyllum*), known as the ‘Sarawak Olive’, is found naturally only in Sarawak; it is very popular locally and among emigrants from the region. However dabai is very perishable fruit with a shelf life of 2-3 days limiting its markets to nearby towns from its production areas. It is consumed fresh after soaking in warm water (60°C) for about 15 min. Most trees are seedlings (with inherent variability of fruit quality), trees are very large (harvest problems presented), they are located away from easy access (many are grown adjacent to rivers and fruit has to be transported to nearby towns by boat creating transport challenges), and there is poor local infrastructure in relation to packing and cooling facilities, reliable electricity supplies, and transport systems between population centres. Recent

development of a freezing package enables storage of frozen dabai fruit for up to a year, making it available year round for marketing to markets further afield and for down stream activities of value-added products. We report on the status of, and suggest improvement, to the dabai supply chain, to maintain postharvest fruit quality during extended storage and transport of this desirable tropical fruit to regional, national and international markets.

114 [f999; h999 / b007](#)

Title Technical and socio-economic recommendations for the post-harvest system of fruits and vegetables vis-à-vis the market and food security focusing on Latin American and caribbean countries

Author J. Danilo and L. Mejía

Citation ISHS Acta Horticulturae 906:125-135.2011.

Keywords Good Agricultural Practices; produce; worldl; food chain

Abstract

The world production of fruits and vegetables has increased in the last years, not only because of the population growth but also for reasons related to health. Knowledge about how to handle fruits and vegetables during the post-harvest phase is as important as the production phase. In order to avoid qualitative, quantitative and, consequently, economic losses of fruits and vegetables during the post-harvest phase, it is suitable to identify and establish technologies and procedures that help to prevent losses, preserve quality and maintain the safety of the produce. That way it may access to a more competitive and fair market. This article deals with relevant issues to be considered in a post-harvest system with emphasis on the needs of Latin American and Caribbean countries. It is addressed to small and medium farmers of developing countries, highlighting the concepts of Good Production Practices (GPP), Good Practices on Post-harvest Handling (GPH), also the concepts of quality and safety applied to fruits and vegetables, for achieving not only market, but also food safety. Further, it is mentioned that an adequate post-harvest system management at small and medium levels for fruits and vegetables requires basic knowledge of the biochemical and physiological behaviour of each crop, but also familiarity on infrastructure and technologies along with socio-economic strategies, and the need to integrate stakeholders through alliances of productivity along the food chain. Key issues in post-harvest are highlighted without forgetting the environmental aspect and considering simple alternatives of processing for fruits and vegetables. Finally, some conclusions and recommendations are listed.

115 [f999; h999 / b000](#)

Title The realities of good agricultural practices certification
Author R. Yudin
Citation ISHS Acta Horticulturae 906:83-90.2011.
Keywords farm certification; farm audits; food safety; Better Management Practices

Abstract

In the last two decades food-borne disease outbreaks linked to fresh produce have led to increasing public concern over food safety; buyers now demand that horticulturalists demonstrate their product will not cause harm, through external verification of safer work methods by independent certification companies. Competing and overlapping certification schemes make compliance with market requirements onerous and costly for growers, they also need to concentrate on certain core areas in order to guarantee a safe product, and minimize commercial difficulties arising from non-conformance with differing audit criteria. These areas of concern were identified during the author's ten years experience with several standards, as applied in twelve countries. The principal recurrent problems in all types of farm audits shall be identified, their causes briefly discussed, and the best practices required.

116 [f008; h002; h999 / b000](#)

Title Tropical fruit genomes and postharvest technology
Author R.E. Paull, N.J. Chen, H. Turano, B. Irikura and Pingfang Wu
Citation ISHS Acta Horticulturae 906:237-244.2011.
Keywords genome sequencing; fruit ripening; gene expression; phytohormones

Abstract

Sequencing of tropical fruit genomes is entering a new phase, as sequencing technology undergoes dramatic changes in speed and cost. The three major steps in genome sequencing are: actual sequencing, application of bioinformatics to predict genes and confirming the identity of the predicted gene. Full genome sequencing and expressed sequence tags, often coupled to microarray technology, provide the possibility to determine the genes expressed and their regulation at specific stages of fruit

development. The most difficult is the third step of connecting predicted genes to physiological function and directly confirming that connection.

Papaya (*Carica papaya* L.) is the first fleshy fruit with a climacteric ripening pattern to be sequenced. As a member of the Rosids superorder in the order *Brassicales*, papaya apparently lacks the genome duplication that occurred twice in *Arabidopsis*. The predicted papaya genes that are homologous to those potentially involved in fruit growth, development, and ripening were investigated. Compared to *Arabidopsis* and tomato, fewer genes were predicted in papaya that may impact sugar accumulation, ethylene synthesis and response, respiration, chlorophyll degradation and carotenoid synthesis. Similar or fewer genes were found in papaya for the enzymes leading to volatile production than so far determined for tomato. The presence of fewer papaya genes in most fruit development and ripening categories suggests less subfunctionalization of gene action. The lack of whole genome duplication and reductions in most gene families and biosynthetic pathways make papaya a valuable and unique tool to study fruit evolution and the complex regulatory networks active in fruit ripening. The regulatory networks present an opportunity to modify ripening, fruit quality, phytonutrient content and postharvest disease resistance. The data also suggest that direct physiological homology and gene action may not occur between different fruit species.

117 [i001; k001 / b000; a003](#)

Title Effect of ultraviolet-A irradiation on the quality of harvested agricultural products during the drying process

Author H. Aoki, K. Sukegawa and Y. Daikokuya

Citation ISHS Acta Horticulturae 907:101-104.2011.

Keywords amino acid; catechin; green tea; protease activation; rice husk

Abstract

Harvested agricultural products are traditionally dried by exposure to direct sunlight. Sun drying is weather-dependent and, thus, drying time may be limited. Hot-air drying is expensive and may also affect taste. Thus, ultraviolet-A (UV-A) irradiation is investigated as a possible factor for the superior taste of sun-dried products. The effect of UV-A on the free amino acid content of postharvest green tea leaves and rice husks was investigated in order to develop a UV-A irradiation drying system. Postharvest samples were subjected to hot-air drying with simultaneous irradiation at red, green, blue, UV-A, and UV-C wavelengths and with no irradiation. The total free amino acids of 17 free amino acids and total

catechin content in the leaves was measured by HPLC. The antioxidant activity of the leaves was measured using stable radical DPPH and was expressed as the Trolox concentration. UV-A exposure produced an increase in the mean content of 17 free amino acids in green tea leaves. Irradiation at visible blue and UV-A wavelengths of green tea leaves caused a larger increase in antioxidant activity than other treatments. In the case of rice husks, UV-A irradiation produced larger increases in amino acid content of 16 free amino acids in rice bran compared to that in both sun drying and hot-air drying alone treatments. There were a few differences in both the gelatinization characteristics of the polished rice and the germinating rate of husks. However, the superior taste of sun-dried products may be attributable to the improved decomposition of proteins by UV-A irradiation.

118 [h063 / b006](#)

Title Advances in postharvest management of pears

Author D. Sugar

Citation ISHS Acta Horticulturae 909:673-678.2011.

Keywords *Pyrus communis*; pear ripening; postharvest fungicides; 1-MCP; superficial scald

Abstract

The need for postharvest conditioning in order to induce ripening capacity limits early-season marketing of several winter pear cultivars. The length of time needed to induce ripening capacity decreases with later harvest, with increasing duration of exposure to ethylene, and with increasing storage temperature. Peak efficiency for inducing ripening capacity in 'd'Anjou' and 'Comice' pears was at 10°C. Recent postharvest fungal decay research has demonstrated the value of fungicide applications 1-2 weeks pre-harvest, integrated with orchard calcium sprays, timely harvest, and prompt application of postharvest fungicides or biocontrol agents. A predictive model for risk of postharvest infection by *Botrytis cinerea* showed the utility of sampling fungal DNA on the fruit surface at harvest, but proposes that overall orchard quality (presence of dead limbs and tall weeds) is highly predictive of gray mold decay. Postharvest-applied fungicides fludioxonil and pyrimethanil have been effective in the USA when applied soon after harvest, albeit with risk of resistance development. Use of biocontrol agents for postharvest decay is developing slowly in limited geographic areas. Implementation of 1-MCP to enhance European pear storage is problematic due to risk of excessive inhibition of ripening. Simultaneous treatment with 1-MCP and ethylene (1:1) and post-storage conditioning at 10°C prior to ripening show promise for overcoming this obstacle. Fine control of 1-MCP dosage may be compromised by wooden or other

organic container materials, especially when wet. Dosages of 1-MCP sufficiently low to avoid ripening inhibition may be of value in inhibiting superficial scald, especially in combination with antioxidant treatments. Uniform treatment with low dosage 1-MCP may be difficult to maintain, and response may vary among fruit lots and seasons. Storage at very low levels of oxygen can inhibit superficial scald development, but in some cases with increased risk of other physiological disorders.

119

[h063 / b001](#)

Title Development of a pre-harvest prediction model for ripening of 'Forelle' pears (*Pyrus communis* L.)

Author E. Lötze, A. Sadie and K.I. Theron

Citation ISHS Acta Horticulturae 909:693-698.2011.

Keywords firmness; heat units; hours below; days after full bloom

Abstract

This study was initiated to correlate pre-and post-bloom temperature variables from two of the main pear production areas, Ceres and Elgin, with the most important physiological maturity variables, in order to predict harvest maturity of 'Forelle' pears more accurately. Although fruit firmness is often used to quantify optimum harvest maturity of pears, quantifying optimum harvest maturity for 'Forelle' pears cannot rely on firmness only. Firmness has been found to be lower in a season with relatively low summer temperatures, thus climate has to be considered when this parameter is used for prediction of harvest maturity. Therefore, climate parameters from the onset of winter (May) until beginning of summer (December) were included in the prediction model. The weekly maturity variables were plotted over the length of the growing season (corresponding DAFB), accumulated chill units, accumulated heat units and hours below 10°C and monthly heat units for the season - from full bloom to optimum harvest maturity for each physiological variable (firmness=6.1 kg; malic acid=0.27; total soluble solids=14.6; back ground colour >2.5) to determine the effect of climate on maturation of 'Forelle'. Using regression analyses, a straight line was fitted over the linear interval where the optimum for each maturity variable was situated. For every regression line, the equation of the fitted line was used to estimate the number of DAFB or specific climate parameter to determine the optimum of the selected maturity variable. The gradient of each fitted line was used to quantify the rate at which the variables changed over the number of days after full bloom and heat units. A prediction model was developed for each site, based on 10 years of historical maturity indexing and hourly climate data.

120 [h063 / b006](#)

Title Effect of different CA storage conditions on storability and fruit quality of organically grown 'Uta' pears

Author G. Lafer

Citation ISHS Acta Horticulturae 909:757-760.2011.

Keywords *Pyrus communis*; controlled atmosphere; dynamic controlled atmosphere; fruit firmness; optimal harvest date; storage disorders; storage diseases

Abstract

Fruit from 5-year-old *Pyrus communis* L. 'Uta' trees on rootstock 'Kirchensaller' were harvested in 2007 at two different stages of maturity from the same transitional organic orchard. After harvest, fruit of each stage of maturity (ca. 80 kg) were stored for approximately 6 months under different storage conditions: standard controlled atmosphere (SCA) and dynamic controlled atmosphere (DCA). Recommended SCA conditions were used as a reference (1.0°C, O₂ 2.5%, CO₂ 1.0%) and DCA was based on the fruit fluorescence response to low oxygen stress, with O₂ set at 0.4 to 0.6% plus 1.0% CO₂. After storage and a 7-day shelf-life period at 20°C fruit quality was assessed automatically with the 'Pimprenelle' laboratory device. Browning disorders (cavities, flesh and brown core) and storage diseases were evaluated visually. DCA storage maintained firmness and total soluble solids at higher levels than SCA. DCA storage technology reduced browning disorders by more than 44% and fungal decay by 41% compared to fruits stored only in normal CA. Neither low O₂ nor external CO₂ injury was observed in DCA. All results taken into account, the percentage of marketable fruits was highest after nearly 6 months storage when fruit were picked at their optimal stage of maturity and stored in DCA conditions.

121 [h063 / b006](#)

Title Evaluation of phosphine gas as a quarantine treatment for obscure mealybug for export markets

Author L. Cichón, S. Garrido, R. Gómez, D. Fernández, L. Argañaraz and G. Gastaminza

Citation ISHS Acta Horticulturae 909:479-484.2011.

Keywords *Pseudococcus viburni*; quarentenary pest; phosphine; control; pears

Abstract

Obscure mealybug (*Pseudococcus viburni* (Hemiptera: Pseudococcidae)) is present in the pome orchards of the Upper Valley of Río Negro and Neuquén. It is a quarantine pest of actual and/or future importance for the markets of Argentina (Korea, Panama, Japan, Mexico, New Zealand). The objective of the present study was to evaluate the efficiency of phosphine gas as a control agent for *P. viburni* against the egg stage, which is the most tolerant developmental stage. The rearing and infestation of *P. viburni* was artificially carried out on 'd'Anjou' pears. Two eggs (300 eggs per treatment) were placed in the calyx of each fruit. Infested fruit were placed in hermetic chambers and received 1000 ppm of phosphine at 0°C, with different times of exposure (I: 24 h, II: 48 h and III: 72 h). For each treatment a control was assigned, which was only exposed to 0°C. When the treatments reached the time of exposure the fruits were ventilated and the evolution of the eggs was observed for 60 days at 24°C. When the eggs hatched, the nymphs were placed on new fruits and were observed until they reached the adult stage. A Multiple Comparison Analysis was used to compare the proportions, using the Bonferroni correction for the comparison of the significance values between pairs. The exposure of the egg stage to a phosphine concentration of 1000 ppm during 48 or 72 h had an efficacy of 99,00 and 98,99% respectively (CI:95%). These results demonstrate a good positioning of treatments II and III as risk mitigation methods for *P. viburni* when this pest is listed as quarentenary for external markets.

122

[h063 / b000](#)

Title Factors affecting sensitivity of 'Abate Fetel' pears to friction discoloration
Author T. Gomila, G. Calvo and A.P. Candan
Citation ISHS Acta Horticulturae 909:687-692.2011.
Keywords *Pyrus communis*; postharvest; fruit quality; mechanical damage; friction discoloration; 1-MCP

Abstract

Friction discoloration (FD) is one of the main postharvest problems of 'Abate Fetel' pears. During 2009 and 2010, the effect of maturity, 1-methylcyclopropene (1-MCP), temperature and degree of dehydration of fruits on their susceptibility to FD were evaluated in 'Abate Fetel' pears grown in the Alto Valle of Río Negro, Argentina. Three replicates of 40 fruits were used in each treatment, and they were exposed to 120 s of rotation on rollers with synthetic bristle brushes at a constant speed. After 24 hours at 20°C, the incidence and severity of FD was visually assessed. Fruit maturity at harvest did not affect fruit

susceptibility. 1-MCP treatment significantly reduced sensitivity to FD after 60 and 120 days in storage. When fruit treated with 1-MCP showed a weight loss higher than 2%, FD incidence was similar to control. Fruits with low water loss were less sensitive to FD. When weight loss was close to 1%, fruits were less sensitive than when weight loss was higher than 2%. The lowest sensitivity temperature range was found between 7-10°C, with greater sensitivity at temperatures near 0°C and above 15°C. The results demonstrated the importance of minimizing the time between harvest and packing, as this reduces water loss. The adoption of storage practices that reduce weight loss and fruit ripening should be considered to reduce sensitivity to FD.

123

[h063 / b000](#)

Title Fruit rot caused by *Phytophthora* sp. In cold-stored pears in the valley of Rio Negro and Neuquén, Argentina

Author C. Dobra, M.C. Sosa, M.C. Lutz , G. Rodriguez, A.G. Greslebin and M.L. Vélez

Citation ISHS Acta Horticulturae 909:505-510.2011.

Keywords *Phytophthora*; postharvest diseases; fruit rot; 'Williams'; 'Packham's Triumph'; pears

Abstract

Pear fruit conservation for long periods is associated with postharvest fungal diseases. In Argentina, the most important and widespread diseases are caused by *Penicillium* spp. and *Botrytis cinerea*, followed by *Alternaria* sp. and *Cladosporium* sp. and *Athelia epiphylla*. The last one can be important depending on the fruit-lot. This study reports the presence of one Oomycete, as the cause of pear fruit rot in postharvest. In 2010, during the first months of conservation of 'Williams', 'Packham's Triumph' and 'Red Bartlet' pears, in cold storage, in the eastern area of Alto Valle of Río Negro, fruit decay was recorded with losses between 5 and 20%, according to fruit-lot. Symptoms of decay were studied and its ethiology was determined using conventional and molecular methods. Fruit started showing circular, light to dark brown areas with irregular and diffuse margins that spread rapidly. The decayed area remained firm. The lesion diameter increased and it extended to pulp tissue to reach fruit core with a hyperbolic shape, different from the spherical shape caused by *Penicillium* spp. or *Botrytis* sp. The pathogen was isolated in V8 agar selective medium from pears with symptoms. By morphologic characteristics (colony and sporangia) of isolates, its association with clade 6 of *Phytophthora* was determined. The identification of isolates was confirmed by direct sequencing of the ITS rDNA region using DC6 and ITS4 primers. The nucleotide sequence showed 100% of similarity (745/745 pb) with

sequences available in GenBank and was identified as an undescribed species inside *P. gonapodyides*-*P. megasperma* Clade 6. This is the first report of a new *Phytophthora* in postharvest pears.

124 [h063 / b001](#)

Title Harvest maturity, conditioning temperature, and ethylene treatment influence induction of ripening capacity in 'd'Anjou' pear fruit

Author D. Sugar and T.C. Einhorn

Citation ISHS Acta Horticulturae 909:719-724.2011.

Keywords *Pyrus communis*; pear ripening

Abstract

The relationship between 'd'Anjou' pear fruit maturity at harvest and postharvest conditioning necessary to induce ripening capacity at -0.5, 5, or 10°C was studied at two locations in Oregon. Fruit were harvested weekly for five weeks beginning at 66.7 N and conditioned for 10, 20, 30, 40, 50, or 60 d at each temperature. After 7 d ripening at 20°C, fruit firmness was measured and the conditioning duration corresponding to fruit softening to ≤ 17.8 N was calculated. At -0.5°C, ~60 d were required to induce ripening capacity in fruit harvested at initial maturity. This decreased to a minimum of ~22 d when pears were harvested 28 d later. At 5°C, fruit harvested at initial maturity required ~30 d to achieve ripening capacity, while those harvested 28 d later needed only 2 d. At 10°C, fruit harvested at initial maturity required ~18 d to achieve ripening capacity; pears harvested 21 and 28 d after initial maturity required less than 10 d at 10°C. The relationship between harvest timing and the conditioning duration necessary to induce ripening at each temperature was well-described by second-order polynomial regression. Using this relationship, the conditioning duration necessary to induce ripening capacity in 'd'Anjou' pears at -0.5, 5, or 10°C corresponding to specific harvest timings can be calculated from the regression equations. 'd'Anjou' pear fruit harvested at 66.7 N treated with 100 ml L⁻¹ ethylene at 20°C for 24 h required additional conditioning of 30 d at -0.5°C, 20 d at 5°C, and 7 d at 10°C to develop ripening capacity. After 48 h in ethylene an additional 20 d at -0.5°C, 8 d at 5°C, and 4 d at 10°C were required. Ethylene treatment for 72 h required no additional conditioning.

125 [h063 / b001](#)

Title Non-destructive index to characterize the maturity of 'Williams' pears grown in Argentina

Author T. Gomila, G. Calvo and A.P. Candan
Citation ISHS Acta Horticulturae 909:751-756.2011.
Keywords *Pyrus communis*; postharvest; Vis-spectroscopy; chlorophyll; ethylene production; climacteric peak

Abstract

Determining the maturity at harvest is crucial for storage and marketing of pears. In recent years non-destructive techniques were evaluated. In this study we used spectroscopy in the Vis-NIR range, and established the AD index (absorbance difference) as the difference between the average value of absorbance between two points near the peak of chlorophyll absorption: 677 and 722 nm. Fruits were harvested between 93 and 131 days after full bloom (DAFB) and ethylene production, traditional maturity indexes and the AD index were determined on each date. Four significantly different maturity groups were characterized by their ethylene production pattern: immature (<99 DAFB), transition (102-105 DAFB), intermediate (107-124 DAFB) and late (>126 DAFB). AD values decreased with advanced harvest and had a high correlation with ethylene production. AD could better discriminate the 'late' harvest group than other traditional indexes such as flesh firmness. During shelf life, AD evolution showed a high correlation with the different stages of ethylene production of climacteric fruit: pre-climacteric, rising phase and climacteric. Preliminarily, it was established that AD values between 1.45 and 0.85 correspond to the pre-climacteric, between 0.85 and 0.50 to the rising phase, and values below 0.5 for climacteric. We conclude that AD index can be useful to identify the physiological changes that occur during 'Williams' ripening, with the advantage of being an instant and non-destructive determination.

126 [h063 / b001](#)

Title Post-harvest performance of 'Abate Fetel' pears grown in Argentina in relation to harvest time
Author G. Calvo, A.P. Candan and T. Gomila
Citation ISHS Acta Horticulturae 909:725-730.2011.
Keywords ethylene; maturity; 1-MCP; superficial scald; friction discoloration

Abstract

The area planted with 'Abate Fetel' pears has increased in Argentina in recent years, and the trend suggests it will continue to increase in the near future. Because the information available for harvest and

postharvest handling is limited, the aim of this study was to generate new local information on maturity indexes and 1-MCP effect on ripening, superficial scald, and friction discoloration. Four harvest dates were evaluated, from 23 January to 16 February. The results showed that the maturity parameters most closely related to the advance of maturity were firmness, skin color and starch degradation. Fruit harvested on 23 January and 6 February was treated with 0 or 0.30 $\mu\text{l L}^{-1}$ 1-MCP and then stored at -0.5°C for 60 and 120 days. 1-MCP treatment significantly reduced ethylene production and fruit ripening for the two harvest dates after 60 and 120 days of storage and subsequent shelf life. Fruit firmness and color were the most affected parameters, and to a lesser extent, titratable acidity. Superficial scald developed only in control fruit after 120 days, affecting 18 and 33% of the fruit harvested on 23 January and 6 February, respectively. 1-MCP controlled the disorder completely. Susceptibility to this disorder was not related to maturity at harvest, but the percentage of fruit affected by friction discoloration was greater in late harvested fruit and it increased as storage extended. 1-MCP reduced the number of fruit with moderate and severe friction discoloration.

127

[h063 / b001](#)

Title Relationship between maturity index and ethylene production patterns of 'Williams' pears grown in the Alto Valle of Rio Negro

Author T. Gomila, G. Calvo and A.P. Candan

Citation ISHS Acta Horticulturae 909:745-750.2011.

Keywords *Pyrus communis*; postharvest; harvest date; climacteric peak; ripening

Abstract

The Alto Valle of Río Negro is the most important pear production region of Argentina and 50% of this production is of the 'Williams' cultivar. The aim of this study was to characterize maturation of 'Williams' pear according to ethylene production and determine its correlation with the maturity index traditionally used. During 2009 and 2010 seasons, fruit samples were taken between 93 and 131 days after full bloom (DAFB) to determine maturity indices (flesh firmness, soluble solids, acidity, starch degradation, epidermis color) and ethylene production. DAFB had the greatest correlation with ethylene production. The number of days required to start ethylene production and to reach the climacteric peak decreased as harvest dates advanced, leading to the identification of four maturity groups: immature (<99 DAFB), transition (102-105 DAFB), intermediate (107-124 DAFB) and late (>126 DAFB). None of the assessed maturity indices could discriminate between the groups identified, showing significant

differences only in some cases. Flesh firmness values close to or less than 20 pounds made it possible to discriminate between immature and transition groups. Results also showed that changes observed in ethylene production during the last maturity period were not reflected by firmness values, suggesting that other complementary maturity indices should be taken into account.

128 [h063 / b006](#)

Title Ripening induction of 'Packham's triumph' pears treated with 1-methylcyclopropene (1-MCP)

Author A.P. Candan and G. Calvo

Citation ISHS Acta Horticulturae 909:731-737.2011.

Keywords ethylene; maturity; ripening inhibition; reversion; superficial scald

Abstract

Commercial use of SmartFresh[®] in pears requires applying a concentration of 1-methylcyclopropene (1-MCP) sufficient to delay the maturity process, but which still allows the proper ripening of the fruit after storage. The aim of this study was to evaluate the effectiveness of various approaches to reverse the effect of 300 and 600 ppb of 1-MCP on 'Packham's Triumph' pears. Simultaneous pre-storage application of 1-MCP with ethylene (300 and 600 ppb) or CO₂ (5%) and post-storage temperature treatments (2 or 3 weeks at 17°C before re-entering storage) were assayed. The ethylene production and maturity indexes were evaluated after 160 and 230 days at -0.5°C. All the treatments reversed the ripening inhibition caused by 1-MCP. Fruit receiving simultaneous application of 300 ppb 1-MCP with 300 ppb ethylene completely reversed the effect of 1-MCP treatment and showed no significant differences with untreated control fruit. Simultaneous application of 600 ppb 1-MCP with 600 ppb ethylene or 5% CO₂ were effective only after 230 days of storage plus shelf life. A temperature treatment of 3 weeks at 17°C was effective to reverse 1-MCP effects after 160 days of storage while 2 weeks at 17°C were enough when storage extended up to 230 days. Results showed the importance of considering the length of storage to decide on the most appropriate reversion treatment.

129 [h063 / b000](#)

Title Sensory evaluation of pears: a useful tool to detect changes in eating quality during ripening

Author M.D. Raffo, A.P. Candan, V. De Angelis, L. Mañueco, M.J. Miranda and N. Barda

Citation ISHS Acta Horticulturae 909:651-656.2011.

Keywords maturity stage; trained panel; 'Bartlett' pear; taste attributes; texture

Abstract

Since pears are very perishable once they are ripe, they are generally purchased unripe and require a few days at room temperature to reach maturity. Consumers complain that pears advance from unripe to overripe in a very short time. The rapid loss of eating quality is sometimes indicated as a reason why consumers do not buy pears. For consumers, it is very important to know how to ripen the fruit as well as the sensory attributes that are associated with different maturity stages. The aim of this work was to quantify the sensory changes induced by conventional cold storage and subsequent ripening at room temperature using descriptive sensory analysis as a tool. 'Williams Bon Chretien' (also known as 'Bartlett') pears were stored for 60 days at 0°C and then ripened at 20°C for 0, 1, 3 or 5 days followed by sensory evaluation by a trained panel. Statistically significant differences were observed for intensity of aroma attributes, flavor intensity, firmness, meltiness and juiciness between pears that were ripened for different durations. The unripe fruit evaluated at room temperature showed little taste, low flavor intensity and juiciness, and high firmness. After 5 days of ripening, pears were much lower in firmness and crispiness. Although the aroma intensity was higher after 5 days of ripening, this was primarily due to the development of defective aromas such as solvent, alcohol and fermented. It can be concluded that the pears attained their best sensory quality after ripening for 3 days at room temperature.

130 [h063 / b006](#)

Title Storage of pears using dynamic controlled-atmosphere (DCA), a non-chemical method

Author R.K. Prange, J.M. DeLong and A.H. Wright

Citation ISHS Acta Horticulturae 909:707-717.2011.

Keywords chlorophyll fluorescence; superficial scald; lower oxygen limit; LOL; anaerobic compensation point; ACP; ILOS

Abstract

Storing of some pear cultivars has usually included a reliance on postharvest chemical treatments, e.g., ethoxyquin or diphenylamine, to control superficial scald. The current trend towards elimination of pre- and post-harvest synthetic chemical treatments in Europe and other markets necessitates a change to reliance on other, preferably non-chemical, methods to achieve scald and quality control. Previous

research has demonstrated this can be accomplished with storage at very low O₂ levels. Wide-spread adoption, however, has not taken place due to concerns of anaerobic damage when the pear fruit are held below the lower oxygen limit (LOL) for long periods of time. Dynamic controlled-atmosphere (DCA) storage is able to identify the LOL of pears using chlorophyll fluorescence. It is termed 'Dynamic' CA since it allows the storage manager to customise the O₂ concentration at the beginning of storage and change it during storage, as the LOL changes. DCA is appealing because it: 1) is non-chemical, 2) uses existing CA technology, 3) can be monitored electronically in real-time, 4) extends the storage time of fruit, 5) controls superficial scald and other storage disorders, and 6) can warn the operator of equipment malfunctions, e.g., refrigeration and CA equipment failure. The principal of DCA is based on the discovery that a sudden increase in the fruit's fluorescence occurs at the LOL. If the O₂ concentration is increased, by as little as 0.2% above the LOL, the fruit can be safely stored. This has allowed apples and pears to be stored below 1.0% O₂ and as low as 0.4% O₂, thereby achieving both longer storage life and superficial scald control in scald-prone fruit. DCA has been used commercially since 2004. In 2010, ca. 300,000 to 400,000 bins of fruit were stored using this technology, mainly in the North American and European apple industries. Its use is increasing at more than 40% per year. It is useful for extending the marketing window of pears and as an alternative to ethoxyquin for controlling superficial scald in pear fruit.

131

[h063 / b006](#)

Title Strategies for applying 1-methylcyclopropene (1-MCP) to 'Packham's Triumph' pears
Author D. Manríquez , B.G. Defilippi, C. Moggia, M. Pereira, O. Hernández and J.A. Yuri
Citation ISHS Acta Horticulturae 909:699-706.2011.
Keywords softening; color change; fruit quality; ethylene

Abstract

Two of the main problems during postharvest of 'Packham's Triumph' pears (*Pyrus communis* L.) are premature yellowing and flesh softening, and both processes are controlled by ethylene in this fruit crop. On the other hand, many postharvest strategies have been developed in order to extend postharvest life in pears, including controlled atmosphere, ethylene scrubbers and 1-MCP (SmartFresh™) applications after harvest. The application of 1-MCP in 'Packham's Triumph' pear has shown an effective control of ripening; however its effect is quite strong and in some cases the fruit takes a long time to reach an eating stage, especially when the application is performed immediately after harvest. The objective of this study

was to evaluate two different strategies of 1-MCP applications in order to reduce the time of reaching a ready-to-eat stage. 'Packham's Triumph' pears were treated with 1-MCP (at 200 ppb per 24 h) at harvest and after 15 or 30 days in cold storage. A second strategy was to apply 1-MCP in combination with ethylene (C₂H₄) at harvest. After the application, all the treatments were stored at 0°C, and a group of physiological and quality parameters were evaluated at removal from cold storage and after a shelf life period at 20°C. The strongest delay in ripening occurred in fruit treated with 1-MCP immediately after harvest. They had very low ethylene production and respiration rates and maintained firmness and green color longer than the other treatments. The 1-MCP treatment applied after a cold storage period or in combination with ethylene at harvest had a ripening response intermediate between 1-MCP applied immediately after harvest and the control fruit without treatment which ripened the fastest. This effect may provide an alternative for applying 1-MCP in 'Packham's Triumph' and possibly other pear cultivars.

132

[h063 / b006](#)

Title Temperature and ethylene: two useful tools to be used in combination with SmartFreshSM (1-mcp) for delivering optimal quality pears

Author A. Cucchi and G. Regioli

Citation ISHS Acta Horticulturae 909:679-686.2011.

Keywords 1-MCP; SmartFreshSM; ethylene; temperature; pear

Abstract

SmartFreshSM (1-MCP) has demonstrated its efficacy when used for pear storage, but with the potential issue, on some cultivars or with early harvests, of delaying the softening of fruit during shelf life. Two useful tools to deliver quality pears overcoming this issue of hard fruit are herewith presented, namely temperature management during storage (which implies also lower energy input) and application of low doses of ethylene together with 1-MCP. Results are presented from trials in European countries and South Africa. Preliminary positive results have been obtained when increasing the storage temperature from -0.5 up to 1.5°C on 'Abbé Fétel', 'Conference' and 'Blanquilla' cultivars, and using commercial doses of 1-MCP applied in the ratio of 1:0.5 to 1:2 with ethylene on 'Conference' and 'Packham's Triumph' cultivars. Both tools delivered fruit which softened according to market requirements, while keeping the expected high quality including the reduction of superficial scald and bruising, whenever present.

133 [h063 / b000](#)

Title Two selection strategies of epiphytic native yeasts with potential biocontrol capacity against postharvest pear pathogens in patagonia

Author M.C. Lutz, A. Robiglio, M.C. Sosa, C.A. Lopes and M.P. Sangorrín

Citation ISHS Acta Horticulturae 909:761-768.2011.

Keywords postharvest diseases; antagonistic microorganisms; *Penicillium expansum*; *Botrytis cinerea*

Abstract

To reduce the use of fungicides, biological control with yeasts has been proposed worldwide in recent years. In order to find antagonistic yeasts adapted to pear storage conditions (-1/0°C for 7 months), two isolation strategies were explored. In 2007 (strategy A), the yeasts were isolated from the surface of healthy fruits. Aliquots of the obtained suspensions were seeded on GPY agar and incubated at 26°C. In 2008 (strategy B), washes from healthy wounds after 150 days at 0°C were used to inoculate fresh pear wounds with *Penicillium expansum*. Yeasts were isolated from healthy wounds after 50 days of incubation in cold. From both A and B isolation strategies, one isolate from each yeast species was tested for antagonistic activity against *P. expansum* and *Botrytis cinerea* by in vivo (pear wounds at 0°C) and in vitro (dual cultures at 20°C) assays. By means of strategy A, six yeast species were identified. Among them, the best antagonists were *A. pullulans* and *R. mucilaginosa*, which reduced only *P. expansum* disease incidence (33%). From strategy B, five of six species obtained, *Cryptococcus weringae*, *C. victoriae*, *Cystofilobasidium infirmominiatum*, *Rhodotorula larynges* and *A. pullulans*, showed the highest antagonistic activity against *P. expansum*; they completely controlled disease incidence at 100 days. Only *Cryptococcus weringae* and *C. victoriae* reduced incidence of *B. cinerea* (80%) at 100 days. Differences between in vivo and in vitro biocontrol assays were observed. In in vitro assays, all yeasts produced a greater growth inhibition of *P. expansum* than of *B. cinerea*. Strategy B was the most effective strategy for the selection of antagonistic yeasts for postharvest disease control.

134 [h063 / b006](#)

Title Use of 1-methylcyclopropene (1-MCP) as a strategy to improve post-harvest life of 'Abate Fetel' pears

Author B.G. Defilippi, D. Manríquez and P. Robledo

Citation ISHS Acta Horticulturae 909:739-744.2011.

Keywords softening; color change; ripening; ethylene

Abstract

Ethylene plays an important role in coordinating the ripening process in climacteric fruit, including pears. Regarding 'Abate Fetel', despite having good storage potential, little information is available about the effect of ethylene inhibition (pre- and postharvest) in the development of quality attributes. Therefore, the main objective of this study was to evaluate the effect of two formulations of 1-methylcyclopropene (1-MCP), one applied preharvest (Harvista™ Technology) and the second one after harvest (SmartFresh™). In order to develop a commercial strategy, including doses of both formulations, timing of application and storage potential, the trials were performed during three seasons in the same orchard: 2006-2007, 2007-2008 and 2008-2009. Evaluations included both quality and physiological parameters, such as total soluble solids, titratable acidity, flesh firmness, color development, ethylene production and respiration rate, amongst others. In general, the fruit treated with either formulation of 1-MCP maintained higher firmness than the non-treated fruit during cold storage, especially with SmartFresh™. Similarly, during shelf-life the fruit treated with 1-MCP took longer to reach the ready-to-eat stage, both in terms of firmness and color development. As shown for other species, there was an important effect of the maturity stage at harvest and storage time on the effectiveness of both formulations.

135 [i012; i999 / b005](#)

Title Effect of light and packaging on shelf-life of fresh-cut sweet basil (*Ocimum basilicum*) and rosemary (*Rosmarinus officinalis*)

Author R.J. Anderson, J.P. Bower and I. Bertling

Citation ISHS Acta Horticulturae 911:573-578.2011.

Keywords shelf-life; packaging; sweet basil; rosemary

Abstract

The sale of fresh-cut herbs is often adversely affected by poor storage life, even when using low temperature storage and modified atmosphere packaging. The objective of this study was to investigate the role of different forms of packaging and storage conditions in determining the optimal environment for storage and marketing of fresh-cut herbs. Rosemary and sweet basil were placed into micro-perforated packages, which control water loss but allows maintenance of normal atmosphere in the package. Micro-

perforated and non-perforated polypropylene bags were used, with normal and modified atmospheres applied to the non-perforated bags. Rosemary was stored at 1°C for 21 days and basil for 9 days at 12°C. Packages were stored with and without light. Product condition was evaluated visually, the aroma tested organoleptically, and respiration rate and CO₂ concentration in the packages determined. Storage of herbs under light significantly decreased the CO₂ content of bags, and maintained herb aroma. The use of modified atmosphere appeared unwarranted as the best overall quality of both herbs was maintained using micro-perforated bags. High or uncontrolled increases in CO₂ concentrations in the bags resulted in leaf degradation and, hence, loss of colour and aroma, and in the development of blemishes. It is thus suggested that, for both herbs, micro-perforated polypropylene packaging be used, and packs should be stored and displayed in a light environment.

136

[h010 / b006](#)

Title Effect of methyl jasmonate and salicylic acid on chilling injury of 'Eureka' lemons
Author X.I. Sibozza, J.P. Bower and I. Bertling
Citation ISHS Acta Horticulturae 911:409-414.2011.
Keywords chilling injury; methyl jasmonate; salicylic acid; antioxidants

Abstract

Lemons are susceptible to chilling injury when exposed to temperatures below -0.5°C. South Africa produces and exports lemons to countries around the world. The industry continues to lose large amounts of fruit to chilling injury during postharvest storage. Exposing lemons to low temperature (-0.5°C) for a certain period is an obligatory quarantine treatment for disinfestations of Mediterranean fruit fly. However, fruit do not tolerate such temperatures and develop chilling injury - an unsolved problem in the citrus industry. As postharvest applications of methyl jasmonate and salicylic acid have been successfully used in mangoes, guavas and peaches to reduce symptoms of chilling injury. A similar treatment was applied to 'Eureka' lemons. Fruit were sterilized, air-dried and dipped in 1, 10 or 50 µM of methyl jasmonate or 1, 2 or 2.5 mM of salicylic acid for 30 s, waxed with Avoshine[®] and stored at -0.5°C for 0, 7, 14, 21, 28, 35, or 42 days, before being transferred to ambient temperature for 7 days. Measurements of fruit weight, ethylene and CO₂ evolution, electrolyte leakage of the rind, total antioxidant capacity/activity, total phenolics and soluble sugars were taken. Fruit did not develop visual symptoms of chilling injury despite the extended cold storage time. No significant differences (P>0.05) were found between treatments and cold storage time with respect to electrolyte leakage, ethylene

evolution and respiration. However, treatment with 10 μ M methyl jasmonate or 2 mM salicylic acid significantly ($P < 0.05$) reduced fruit mass loss and slowed reduction of total antioxidants during cold storage. Therefore, methyl jasmonate and salicylic acid dips can enhance the resistance of fruit to chilling injury probably through an increase in antioxidant levels.

137

[h027 / b006](#)

Title Effect of postharvest silicon application on 'Hass' avocado fruit physiology
Author K. Kaluwa, I. Bertling and J.P. Bower
Citation ISHS Acta Horticulturae 911:565-571.2011.
Keywords avocado (*Persea Americana* Mill.); silicon; firmness; carbon dioxide; ethylene

Abstract

Avocado fruit are prone to post-harvest pathological and physiological disorders such as anthracnose and mesocarp discolouration. Silicon has been used to minimize the adverse effects of biotic and abiotic stress on fruit quality. This study investigated the effect of silicon application on fruit firmness, carbon dioxide (CO_2) production and ethylene evolution of 'Hass' avocado fruit. Four different sources of silicon (potassium silicate (KSil), Nontox-Silica[®] (NTS), calcium silicate (Ca_2SiO_4) and sodium metasilicate pentahydrate ($\text{SiO}_3\text{Na}_2 \cdot 5\text{H}_2\text{O}$)) were used as postharvest applications. Fruit were dipped into the Si sources at 80 to 1470 ppm Si and subsequently stored at either -0.5, 1, 5°C or 25°C (room temperature). Firmness, CO_2 and ethylene measurements were taken every two days as the fruits ripened. Fruit stored at 5°C were firmer than fruit stored at other temperatures. With respect to net CO_2 production, there were significant differences in temperature means. Fruit stored at -0.5°C produced the highest amount of CO_2 whereas fruit stored at 5°C produced the lowest. There were no significant differences between the treatment means. Results of ethylene evolution showed significant differences between temperature means but no differences between treatment means. Further ultra-structural analysis (EDAX) was conducted to determine the extent of Si infiltration within each treatment. Silicon passed through the exocarp into the mesocarp tissue in fruits treated with high concentrations of silicon, i.e., KSil 1470 ppm. Fruit dipped into dilute Si solutions (80 and 160 ppm) showed Si presence in the exocarp and infiltration of small amounts of Si into the mesocarp. Treatments with NTS showed the lowest Si infiltration. Postharvest application of 1470 ppm Si in the form of KSil seems to be most beneficial, probably as respiration was most suppressed in the KSil 1470 ppm at 5°C treatment.

138

[h001 / b000](#)

Title Effect of ripening on eating quality of 'Keitt' mango chips

Author F. Appiah, P. Kumah, I. Idun and J.R. Lawson

Citation ISHS Acta Horticulturae 911:547-554.2011.

Keywords 'Keitt' mango; chips; physico-chemical changes; eating quality; sensory evaluation

Abstract

Mango (*Mangifera indica*) is consumed, among other reasons, for its pleasant taste and flavour. Mango fruits are rich sources of vitamins A, B and C. They are being increasingly processed into products such as dried mango slices (chips). These products have longer shelf life than fresh fruit and therefore assure all year round availability of mango in various forms. Mango at different stages of ripening possesses different physico-chemical properties. A study was carried out to determine the effect of stage of ripening of fruits on eating quality of 'Keitt' mango chips. Physico-chemical changes were monitored in fruits during ripening. There were increases in levels of Total Soluble Solids and pH while titratable acidity and vitamin C content declined with ripening. Chips showed increased levels of protein and crude fiber with ripening whereas the levels of carbohydrates declined. Magnesium levels in chips increased with ripening whereas the levels of phosphorus, potassium, calcium and sodium declined. Sensory analysis revealed that chips produced from fully ripe 'Keitt' mango fruits were more acceptable than half ripe and unripe in appearance (1.37), taste (1.27), flavour (1.38) and mouth feel (1.45). Texture of chips produced from fully ripe mangoes performed satisfactorily (2.64).

139

[h027 / b006](#)

Title Importance of cold chain maintenance and storage temperature to avocado ripening and quality

Author R.J. Blakey, J.P. Bower and I. Bertling

Citation ISHS Acta Horticulturae 911:555-564.2011.

Keywords postharvest; ripening; mannoheptulose; perseitol

Abstract

The South African avocado industry is export-based, with the majority of fruit exported to Europe. Fruit are cold-stored for a minimum of 28 days with a number of handling points in the cold

chain. These breaks in the cold chain are thought to increase postharvest losses but have not been quantified. Fruit ('Hass') were harvested from Howick and subjected to a 9-h break in cold storage at 5, 10 or 20 days, or a delay of 24 h before cold storage to simulate shipping conditions from South Africa to Europe. Fruit were stored at 1 or 5.5°C for 28 days. After the storage period respiration, ethylene production, firmness, and fruit mass were measured and fruit quality assessed. Fruit only showed significant differences ($P=0.05$) in the physiological parameters on the first day after removal from cold storage, but fruit quality was severely reduced by breaking the cold chain. Storage temperature also had a significant effect on fruit quality. Storage at 5.5°C resulted in only having between 8 and 30% sound fruit while storing fruit at 1°C resulted in an increase in the percent of sound fruit to 80% for the control. In a related study, the concentration of individual sugars was measured in fruit sequentially over a 24-h period to ascertain the loss in total soluble solids during a cold chain break. Fruit lost 45% of mannoheptulose and 17% of perseitol in 24 h at room temperature. Breaking the cold chain anywhere in the shipping process severely reduces fruit quality. This is mitigated by storing fruit at 1°C but the maintenance of the cold chain is critical to fruit quality.

140

[g004 / b006](#)

Title The effect of storage temperature fluctuations on the post-harvest performance of *Rosa hybrid* L. 'Duett'

Author S. Tshwenyane and C. Bishop

Citation ISHS Acta Horticulturae 911:531-536.2011.

Keywords fluctuating temperature; constant temperature; storage; vase life

Abstract

The most fundamental factor in maintaining quality during transport and extending storage after harvest is temperature. The flowers, in this trial, were subjected to a sequence of temperature fluctuation during storage to simulate transport and pack house handling conditions. *Rosa hybrid* L. 'Duett' was stored at 2°C and fluctuated between 2 and 15°C for 10 days on a two day cycle. Temperature fluctuation had a major impact on the respiration rate and vase life of the flowers. The quality of the flowers under the temperature fluctuation was severely affected as indicated by weight loss, wilting, tissue browning and short vase life. The trial demonstrated that exposing 'Duett' to fluctuating has a negative effect. This results in a reduction of vase life which was influenced by the stress the flowers experienced and the disease level. Fluctuating temperature also encouraged the incidence of *Botrytis cineria* on the flowers. It

is clear that temperature fluctuation in flowers can compromise quality and therefore temperature fluctuations in the handling chain and storage should be addressed to improve quality.

141 [o007 / a007](#)

Title An economic overview of Turkish almond sector
Author T. Isgin and B.E. Ak
Citation ISHS Acta Horticulturae 912:843-853.2011.
Keywords almond; foreign trade; production; Turkey

Abstract

Almonds, adapted well to warm temperate regions, are native to Southwest of Asia, covering Iran, Turkey, Syria, and Palestine but nowadays grown widely in the USA, Spain, and Italy. Almond husbandry in Turkey, however, has not yet reached the point desired because the infrastructure necessary to commercially maintain almond trees is not adequate. Being not capable of producing almonds in the desired quantity and quality makes our country a net almond importer although Turkey has the capacity to enhance the yield and quality factors and thereby increase the productivity that may result in higher profits. To break this vicious circle, efforts directed towards the enhancing of area, yield, and production must be accelerated through preventing growers from using almond trees as bordering materials in orchards rather than using them in commercial production. Furthermore, provision of farm credits as well as advantages of modern almond husbandry for almond growers is among the measures that will mitigate the hardship encountered in the Turkish almond sector.

142 [o006 / a000](#)

Title Evaluation of different degree of ripeness and sun-drying process on triacylglycerols composition of *Pistacia vera* l. Oil
Author G. Ballistreri, E. Arena and B. Fallico
Citation ISHS Acta Horticulturae 912:791-794.2011.
Keywords drying; fatty acids; pistachio oil; ripening

Abstract

The composition of triacylglycerols (TGs) and the fatty acids (FAs) distribution of oil extracted from pistachio kernels alters as the nuts ripen. Sun-drying may also affect oil composition. TGs account for more than 90% of the total glycerolipids in pistachio oil. The main TGs found were: LLL, OLL, LLP, OLO, OLP, OOO, and OOP; these accounted for more than 80% of total TGs. The mean concentration of TGs with more polyunsaturated fatty acids (LLL_n, LLL, OLL_n, LnLP, OLL, and LLP) was lower in ripe (29.4%) and dried ripe (29.1%) than in unripe (32.9%) kernels. The FAs detected in the TGs were palmitic (P), margaroleic (Mo), stearic (S), oleic (O), linoleic (L), linolenic (Ln), and gadoleic (G). The saturated FAs, represented by P (C16:0) and S (C18:0), did not change significantly with ripeness and drying process, comprising 13.9% of the total fatty acids composition in unripe samples, 13.8% in ripe samples, and 14.0% in dried ripe samples. Monounsaturated FAs, represented by Mo (C17:1), O (C18:1), and G (C20:1), accounted for 49.5% of total FAs in unripe kernels, 52.7% in ripe kernels, and 52.6% in dried ripe kernels. Polyunsaturated FAs, represented by L (C18:2) and Ln (C18:3), accounted for 36.6% of total FAs in unripe kernels, 33.4% in ripe kernels, and 33.4% in dried ripe kernels. During seed maturation, the percentage of polyunsaturated FAs declined in favor of oleic acid because desaturase became less active in ripe seeds, permitting the accumulation of its substrate (C18:1) into the TGs. The concentrations of C18:2 and C18:3 declined during seed development, indicating decreased photosynthetic activity in ripe seeds because C18:3 is the major FA of photosynthetic biomembranes.

143

[o006 / a010](#)

Title Forecasting of the world pistachio market (supply, demand and price)
Author R. Sedaghat
Citation ISHS Acta Horticulturae 912:819-826.2011.
Keywords forecasting; short run; long run

Abstract

Supply, demand and price forecasting can provide an appropriate context for long running programming of production and exports. Pistachio is the main agricultural produce that Iran is competing with some other producing nations very closely in its production and exports. With regards to the importance of long running programming for pistachio and to avoid any short run decisions, in this research, world price, supply and demand were forecasted for Pistachio from 2006 till 2015. Data on concerned variables during 1986-2005 were collected by visiting governmental organizations and institutions like management and programming organization, agricultural and commercial data sources

and also registered data in FAOSAT. Regression, algebraic average, forecasting with supply and demand factors and ARIMA methods were employed to analyze the data collected. Results revealed that the average world export demand will be promoted by 12.5 percent from the first to the second period. Average world supply also will be increased by 36.7 percent at the same time period. Domestic consumption in producing countries will be also increased by 74.4 percent from the first to the second time period. Average world market price will be enhanced with the growth rate of 52.5 percent in the similar time period. Lastly, it is indicated that any new investment in producing nations can be economical if yield doesn't decrease / remain stable and production costs increase with the rate of less than 52.5 percent from the first period to the second one.

144 o006 / a000

Title Practical application of HACCP in pistachio processing industry - case study: pistachio processing equipment of Momtazan industrial company

Author M. Nakhaeinejad and V. Daneshvar

Citation ISHS Acta Horticulturae 912:797-806.2011.

Keywords Codex; HACCP; ISO 22000; Good Manufacturing Practice (GMP)

Abstract

Food safety shocks can threaten the health of pistachio consumers, creating havoc in the industry which results in severe losses to producers. According to hygienic standards, the method of raw pistachio processing is so substantial. In this paper practical application of Hazard Analysis Critical Control points (HACCP) in pistachio processing industry is described. The concept of (HACCP) is a system that enables the production of safe pistachio according to health and hygienic issues by analyzing the production process. By identifying all hazards that are likely to occur in the processing establishment, the critical points in the pistachio processing are introduced. And different methods of the correctness and accuracy of process can be controlled by monitoring the critical points.

145 o006 / a009

Title The effects of storage on colour of spreadable pistachio nut paste

Author O.F. Gamli , I. Hayoğlu , H. Turkoğlu and B.E. Ak

Citation ISHS Acta Horticulturae 912:777-780.2011.

Keywords

Abstract

Spreadable pistachio nut paste is a green, unique product, consisting of pistachio nut, sugar dust, milk powder, vanillin, margarine and lechitin. It is consumed at breakfast. In this study, spreadable pistachio nut paste containing 9% water, 7% protein, 29% fat, 50-55% carbohydrates and 1% ash was prepared, and the change in its colour (as total chlorophyll content, L*, a*, b* values) during storage at 4°C and 20°C during 8 months was investigated. As a conclusion, discoloration was determined, and L* value decreased at the end of storage period depending on the change in chlorophyll pigments content, and browning reactions.

146

[h026 / b006](#)

Title 1-MCP delays ripening and enhances shelf life and quality of kiwifruit

Author MD. Jameel Jhalegar, R.R. Sharma and R.K. Pal

Citation ISHS Acta Horticulturae 913:373-377.2011.

Keywords 1-MCP; physiological loss in weight; fruit firmness; quality attributes

Abstract

This study was conducted to observe the effect of different concentrations of 1-methylcyclopropene [1-MCP] on postharvest life and quality of kiwifruit (*Actinidia deliciosa* (A.Chev.) C.F. Liang and A.R. Ferguson 'Allison'). Kiwifruit 'Allison' were treated with different concentrations of 1-MCP (0.5, 1, and 2 µl/L) and un-treated fruit served as control. 1-MCP treatment was given for 24 h at 20°C and after treatment, fruit were transferred to ambient storage, and observations on different physical, physiological, biochemical and quality attributes were recorded at 3 day intervals. All concentrations of 1-MCP influenced physiological loss in weight (PLW) and fruit firmness in kiwifruit with 2 µl/L the most effective. PLW in untreated fruit was very high (18.6%) in comparison to 1-MCP treated fruit after 18 days storage, and 1-MCP (2 µl/L) treated fruit were much firmer (31.7 N) than untreated fruit (8.4 N). TSS increased suddenly in untreated fruit on day 6 (12.5%), increased up to day 12 (16.8%) and declined after day 15 of storage (15.7%), whereas in 1-MCP (2 µl/L) treated fruits it increased from day 12 only. 1-MCP (2 µl/L) treated fruit retained ascorbic acid better than other treatments and control. TA decreased during storage and there was no significant difference among treatments.

147

[h026 / b006](#)

Title 1-MCP is an effective tool for reducing detrimental effects of ethylene contamination during kiwifruit storage

Author B.G. Defilippi, P. Robledo and D. Manríquez

Citation ISHS Acta Horticulturae 913:639-645.2011.

Keywords *Actinidia*; fruit quality; fruit softening; 'Hayward'; Smartfresh

Abstract

A major challenge during long term storage of kiwifruit is the maintenance of fruit firmness, which could be seriously affected by ethylene levels due to contamination events. In order to reduce ethylene effects during storage several tools are commercially used, including air ventilation and ethylene scrubbers such as catalytic converters and potassium permanganate. The ethylene antagonist 1-methylcyclopropene (1-MCP) has shown benefits in extending kiwifruit storage life, but its effect has not been tested under ethylene contamination conditions, which was the main objective of this work. To perform the assay, kiwifruit applied with 1 ppm 1-MCP for 24 h immediately after harvest were stored for 90 days at 0°C. Ethylene contamination was performed with 400 ppb of ethylene applied for 72 h at four times during storage, i.e., 0, 30, 60 and 90 days. As already reported, fruit applied with 1-MCP remained firmer after storage than untreated fruit. In terms of contamination, ethylene applied in the first 30 days of storage was the most detrimental in inducing fruit softening. This effect on firmness was evident after 60 days of storage when half the fruit not treated with 1-MCP was at a firmness less than 3 lbf. In contrast, less than 10% of the fruit treated with 1-MCP was under this commercial threshold. No other quality attributes were affected by 1-MCP application or ethylene contamination. Therefore, 1-MCP could be considered as an effective tool for reducing the negative effects of ethylene contamination during storage.

148 [h026 / b004](#)

Title A non-destructive fluorescence method applied to the assessment of the quality of kiwifruit

Author D. Remorini, F. Tardelli, R. Massai, L. Guidi, E. Degl'Innocenti and G. Agati

Citation ISHS Acta Horticulturae 913:547-552.2011.

Keywords *Actinidia deliciosa*; chlorophyll; emission spectra; flavonols; optical sensors

Abstract

Fluorescence spectroscopy was used to evaluate chlorophyll (Chl) concentration in kiwifruit. The excitation light of suitable wavelengths is able to cross the external fruit skin and to reach chlorophyll in the pericarp. This was demonstrated by measuring the Chl fluorescence excitation and emission spectra of intact fruit by a spectrofluorimeter through a double arm optical fiber bundle. The Chl fluorescence signal measured at two emission bands, 685 and 740 nm, was related to the Chl content, because of partial reabsorption of the shorter wavelength by Chl itself. To verify the validity of this relationship 30 fruits were measured using a fluorescence sensor, Multiplex, able to simultaneously detect Chl fluorescence at both red and far-red bands, at a 15 cm distance, integrating on a 6 cm² surface of the wider sides of fruit. The chlorophyll index, CHL Index, was defined as the ratio between the far-red and the red Chl fluorescence signals excited with red light. Pericarp samples were collected from the side of the fruit where measurements had been taken, homogenized and Chl extracted with 80% acetone. A reasonable correlation ($R^2=0.81$) occurred between the non-destructive CHL Index and the Chl *a* concentration expressed as $\mu\text{g/g}$ of fresh weight. The sensor was able to detect differences in Chl content on the two fruit faces, depending on their prior and different exposure to sunlight. Estimated Chl content was higher on the exposed side compared to the unexposed side, as previously reported. The same indication was derived for flavonols also assessed by the Multiplex sensor. The fluorescence method has potential to be a suitable non-destructive tool for fruit sorting and postharvest storage monitoring in kiwifruit where Chl content assessment by colorimetric and/or reflectance analysis is problematic due to skin filtering properties.

149

[h026 / b000](#)

Title Changes in volatile production and sensory quality of *Actinidia arguta* fruit during fruit maturation

Author M.Y. Wang, M. Wohlers, X. Chen and K.B. Marsh

Citation ISHS Acta Horticulturae 913:677-684.2011.

Keywords kiwifruit; fruit flavor; compound; firmness; fruit softening; GC-MS

Abstract

Fruit of *Actinidia arguta* ('Hortgem Tahī', 'Hortgem Rua', 'Hortgem Toru' and 'Hortgem Wha') were evaluated at different softening stages during ripening. The volatiles released from the fruit and their sensory qualities, as assessed by a trained taste panel, were compared with those of *A. deliciosa* 'Hayward' and *A. chinensis* 'Hort16A' fruit. Gas chromatography-mass spectrometry (GC-MS) data indicated that each species had different characteristic volatiles. Straight chain aldehydes and esters were

the dominant volatiles detected during the ripening of *A. arguta* fruit. As in 'Hayward' fruit, the total percentages of (E)-2-hexenal and hexanal, which impart green characteristics, decreased as the fruit softened. Butanoates (fruity characteristics) detected in the fruit increased as fruit firmness decreased. However, in the *A. arguta* fruit, higher levels of terpenes and aldehydes were detected. With fruit softening, sensory perception of acidity decreased but typical kiwifruit odour and flavour intensity (ethyl butanoate) increased. More tropical aroma and a slightly bitter skin taste were also noted by panellists for all tested fruit.

150

[h026 / b006](#)

Title Could preharvest applications of 1-mcp improve postharvest life of 'Hayward' kiwifruit?
Author D. Manríquez and B.G. Defilippi
Citation ISHS Acta Horticulturae 913:595-602.2011.
Keywords *Actinidia*; ethylene; fruit quality; softening

Abstract

One of the main postharvest problems in kiwifruit is flesh softening, this process being in part coordinated by ethylene. Therefore, many postharvest strategies have been developed in order to reduce fruit softening, including early harvest, controlled/modified atmosphere storage, ethylene scrubbers and 1-MCP (1-methylcyclopropene) (SmartFreshSM) applications after harvest, being SmartFreshSM extensively used in the last 3 years in Chile. Under Chilean growing conditions the harvest window is quite extend depending on the growing area, going from March to May, which could be affecting the postharvest behavior of the fruit in terms of quality attributes, including firmness among others. During the last three years, a new formulation of 1-MCP has been developed for applying this molecule in preharvest (HarvistaTM Technology), being the objective of this study to evaluate the effect of this molecule during harvest and postharvest of kiwifruit. For the trials we considered two applications times before harvest and two harvest opportunities based on maturity. At harvest no differences were observed for all the attributes evaluated. But for harvest time, an effect in fruit softening was observed during cold storage showing all the fruit applied with 1-MCP a higher firmness compared to control fruit, being this effect more evident in the second harvest. This effect could be explained by the effect of 1-MCP in ethylene production and respiration rate, where lower rates in both parameters were measured in kiwifruits applied with 1-MCP. In other attributes, such as total soluble solids, titratable acidity and physiological disorders, not major differences were observed.

151 [h026 / b005](#)

Title Effect of heat shrinkable films on shelf life, and quality of tray-wrapped kiwifruits (*Actinidia deliciosa* Chev.)

Author R.R. Sharma, R.K. Pal, S.K. Jha and A. Kumar

Citation ISHS Acta Horticulturae 913:671-676.2011.

Keywords heat shrinkable film; physiological weight loss decay incidence; quality attributes; shelf life

Abstract

Studies were conducted to observe the effect of heat shrinkable films on shelf life and quality of kiwifruit maintained under ambient conditions. Fully mature kiwifruit 'Allison' were either shrink-wrapped in three heat shrinkable films -Cryovac (9 μ) and LDPE (25 μ), polyolefin (13 μ) or were not wrapped at all (control) and then stored at ambient conditions (22-28°C and 62-68% RH). Observations on physiological loss in weight (PLW), decay loss, firmness, and quality attributes including total soluble solids (TSS), acidity, and ascorbic acid content were recorded immediately before packing, and after shrink-wrapping at 3 days intervals. All heat shrinkable films influenced PLW, decay incidence, fruit firmness, and quality attributes of 'Allison' kiwifruit over unwrapped ones. However, best results were obtained with Cryovac (9 μ) films, which exhibited least PLW (2.3%) and decay loss (2.8%), and fruit retained moderately good TSS and retained higher ascorbic acid content over unwrapped fruits after 18 days at ambient storage. Respiration and ethylene evolution rates were influenced by heat shrinkable films with less respiration and ethylene evolution rate in Cryovac wrapped fruits compared to other treatments. All the heat shrinkable films delayed ripening of kiwifruit, but Cryovac films had the most significant effects. Shrink-wrapped fruit showed a steady increase in TSS with increase in storage period, whereas unwrapped fruits showed a sharp increase in TSS up to day 15 and then a steady decline afterwards. The patterns for acidity and ascorbic acid content were similar. These studies indicated that kiwifruit could be packed in Cryovac heat shrinkable films for about 18 days with least PLW or decay loss, and without any adverse effect on fruit quality. After 18 days of storage, fruit were fermented not fit for consumption.

152 [h026 / b004](#)

Title Evaluation of a non-destructive dry matter sensor for kiwifruit

Author C.M. Cantin, A. Soto, G.M. Crisosto and C.H. Crisosto

Citation ISHS Acta Horticulturae 913:627-632.2011.

Keywords *Actinidia deliciosa*; dry weight; postharvest quality

Abstract

In this work we studied the relationship between kiwifruit dry matter (DW) measured using the destructive method with a fruit dehydrator (Nesco/American Harvest[®], Wisconsin, USA) and a non-destructive Kiwi meter sensor (Turoni Inc., Forli, Italy). This was an approach to develop a reliable non-destructive method to predict harvest and postharvest quality based on dry matter. There was a significant, but low correlation between DM determined non-destructively using the Kiwi meter and destructively using the fruit dehydrator (industry standard). Classification models with discriminant analysis were used to segregate kiwifruit into groups according to DM. Using this statistical approach rather than the relationship between the two methods, kiwifruit were consistently segregated into two DM groups, but classification into three groups yielded lower scores. These results indicate that the Kiwi meter is a reliable and fast sensor to segregate kiwifruit according to their DM content that could be considered as a consumer quality at harvest and/or postharvest index. Further work on the optimization of this non-destructive sensor as a tool to define consumer kiwifruit quality is being carried out by our group.

153 [h026 / b006](#)

Title Evaluation of quality changes during shelf-life in minimally processed kiwifruit

Author M.D.C. Antunes, D.A.C. Rodrigues, A.M. Cavaco and M.G. Miguel

Citation ISHS Acta Horticulturae 913:553-557.2011.

Keywords *Actinidia*; fresh-cut; ascorbic acid; citric acid; calcium lactate

Abstract

The importance of fresh-cut fruit and vegetables has increased in recent years. Consumers search for ready-to-eat products that keep their nutritional value and quality through shelf-life. The aim of the present research was to evaluate the quality of fresh-cut 'Hayward' kiwifruit subjected to dip treatments, for 2 min, in 2% citric acid, ascorbic acid or calcium lactate. After treatment, fruit were stored at 4°C for 9 days and during this time were evaluated for firmness, color (CIE Lab), soluble solids content (°Brix), antioxidant capacity by DPPH (2,2-diphenyl-1-picrylhydrazyl), and ORAC (oxygen radical absorbance capacity) methods, total phenolics and ascorbic acid. Firmness was maintained better in fruit treated with

citric acid, °Brix was not affected, color was better preserved in fruit treated with calcium lactate, total phenolics, antioxidant activity and ascorbic acid content in fruit treated with ascorbic acid. Under our experimental conditions, the citric acid treatment was slightly better for preserving firmness, and the 2% ascorbic acid dip was better for retaining the nutritional properties of fresh-cut kiwifruit.

154 [h026 / b000](#)

Title Highly sensitive ethylene detector for on-line measurements on kiwifruits
Author R. van den Dungen, S. Te Lintel Hekkert, S.M. Cristescu and F.J.M. Harren
Citation ISHS Acta Horticulturae 913:651-656.2011.
Keywords laser-based ethylene detector; wound; *B. cinerea*

Abstract

Kiwifruit are extremely sensitive to ethylene (C₂H₄); as little as 5-10 ppbv (1 ppbv = 1 part per billion volume = 1:10⁹) of C₂H₄ will induce fruit softening and make them much more susceptible to pathogen attack (such as *Botrytis cinerea*); maintaining fruit firmness can significantly reduce pathological breakdown. Biological research on the plant hormone ethylene is often hampered by the poor detection limit of available instrumentation. Pre-concentration steps need to be included in the measuring scheme, making traditional methods (GC, GC-MS or dispersive IR absorption techniques) not very specific and time-consuming, resulting in a low time resolution. Since C₂H₄ concentrations in kiwifruit are extremely low, it has to be measured with highly sensitive methods. In comparison to conventional methods, optically based detectors, using lasers in combination with modern spectroscopic techniques, are an excellent option for sensitive monitoring of C₂H₄ in kiwifruit. Sensor Sense developed a highly sensitive on-line laser-based ethylene detector (type ETD-300) that is more than an order of magnitude more sensitive and much faster than other commercially available detectors. With its detection limit of 300 pptv (1 pptv = 1 part per trillion volume = 1:10¹²) and time resolution of 5 s it is unique. Many dynamic processes in single fruit can now be monitored in real time without incubation periods. The suitability of ETD-300 for monitoring the ethylene response in real time from kiwifruit under stress conditions, such as mechanical wounding and *B. cinerea* infection, is demonstrated.

155 [h026 / b001](#)

Title Innovative non-destructive device for fruit quality assessment
Author G. Costa, E. Bonora, G. Fiori and M. Noferini

Citation ISHS Acta Horticulturae 913:575-581.2011.

Keywords DA-meter; kiwi-meter; modeling; fruit quality traits; ripening

Abstract

Maturity at harvest greatly affects kiwifruit storage potential and quality at consumption: if fruits are picked too early, they undergo a precocious softening during storage, and do not reach full flavour and aroma when ripe. In *Actinidia deliciosa*, soluble solids content and dry matter has been proposed as maturity indexes. In *Actinidia chinensis*, the optimal harvest time is determined on the basis of flesh colour (Hue Angle= °H). In the last decade, non-destructive techniques, such as NIRs (Near Infrared Spectroscopy) have been used for evaluating kiwifruit quality. However, these devices require time consuming calibrations and they are used to measure the same parameters which are determined by traditional techniques (SSC; DM, °H). As a consequence, they do not give any added values as compared to the traditional methods to assess fruit quality. Recently, the University of Bologna patented innovative and simplified NIRs equipment (DA-Meter and Kiwi-Meter) which allows to define fruit maturity stage by means of an index based on the difference in absorbance between specific wavelengths (IDA). This index correlates with the main traditional parameters as well as with changes in flesh colour. In addition the availability of simple and portable instrument allow their use on the fruit attached to the trees to monitor the maturation and the ripening evolution, and determine the best cultural management practices (such as pruning, thinning, nutrition, etc) that allow to reduce the fruit ripening heterogeneity and simplify post-harvest management of the fruits. In the present work, results on different cultivars of *Actinidia deliciosa* and *Actinidia chinensis* are reported.

156 [h026 / b004](#)

Title Is dry matter a reliable quality index for 'hayward' kiwifruit?

Author C.H. Crisosto, J. Zegbe, J. Hasey and G.M. Crisosto

Citation ISHS Acta Horticulturae 913:531-534.2011.

Keywords in-store consumer tests; degree of liking; titratable acidity

Abstract

Dry matter (DM) measurement at harvest is being proposed as a quality index for 'Hayward' kiwifruit because it includes both soluble solids (mainly sugars) and insoluble solids (largely structural carbohydrates and starch). From two seasons' data, in-store consumer acceptance was well related to DM.

However, in a harvest season when kiwifruit exhibited high ripe titratable acidity (RTA), RTA also played an important role in consumer acceptance. In both seasons, regardless of RTA, consumers 'liked' kiwifruit that had DM $\geq 16.1\%$. In the 2008 growing season, when RTA was high (RTA $\geq 1.2\%$), a high DM (≥ 16.1) was needed to satisfy consumers. However, with RTA $< 1.2\%$, a lower DM ($\geq 15.1\%$) was required allowing a large proportion of the kiwifruit to satisfy a high percentage of consumers. Many of the DM survey kiwifruit samples had a DM content exceeding 15.1%, but DM varied among vineyards and seasons. DM did not change during cold storage. Thus, DM is a reliable candidate for a quality index, but RTA should also be considered.

157

[h026 / b001](#)

Title Is the 6.2 °brix soluble solids harvest index suitable for 'hayward' kiwifruit from high productivity orchard management systems?

Author J. Burdon, N. Lallu, P. Pidakala and A.M. Barnett

Citation ISHS Acta Horticulturae 913:539-546.2011.

Keywords acclimation; *Actinidia deliciosa*; chilling injury; maturity; postharvest; softening; storage

Abstract

Recent changes to 'Hayward' kiwifruit vine management, productivity and climate may affect maturation, softening behaviour and storage performance of the fruit and, in particular, the relationships between maturation and storage performance. If so, is the 6.2 °Brix soluble solids harvest index used by the New Zealand industry still relevant under these changed circumstances? The relationship between soluble solids accumulation and postharvest performance was investigated using fruit from ten orchard management regimes. Soluble solids content (SSC) was monitored throughout April and May 2009 and fruit were harvested for storage when on average at an SSC of 5.2, 5.9, 6.4, 8.0 and 10.0 °Brix. Current orchard management practices for high productivity affect fruit carbohydrate metabolism, resulting in higher SSC values earlier in the season. The pattern of SSC accumulation is also changed, with the rate of SSC accumulation when fruit are at 6.2 °Brix being slower. The postharvest implications are that fruit may be harvested when less mature than equivalent fruit from orchards not using high productivity practices: this may result in reduced capacity to ripen normally and tolerate low temperatures and thus shorter storage and shelf-life. If harvested later, at a higher SSC, the fruit are more likely to have more typical storage and shelf-life behaviour. Overall, whilst 6.2 °Brix as a harvest index is not incorrect, more

attention should be paid to the actual nature and pattern of change in SSC accumulation when fruit are at 6.2 °Brix, rather than the simple numerical value.

158 [h026 / b000](#)

Title 'Jinyan' - a superior yellow-fleshed kiwifruit cultivar with excellent storage quality
Author C. Zhong, S. Wang, H. Huang and Z. Jiang
Citation ISHS Acta Horticulturae 913:135-143.2011.
Keywords *Actinidia chinensis*; *Actinidia eriantha*; interspecific hybridization

Abstract

'Jinyan' is a superior, yellowed-fleshed kiwifruit cultivar bred by interspecific hybridization between *A. eriantha* and *A. chinensis* and selected from the F₁ seedlings in the Wuhan Botanical Garden. Its fruit has gold yellow flesh, fine and tender in flesh texture, aromatic and sweet in flavor. Average soluble solids content of ripe fruit is 16.0%, maximum 19.8% with 0.86% acid content, and SSC/acid ratio of 18.6. 'Jinyan' fruit are long and cylindrical and the yellow brown skin with very short hair. Average weight of fruit is 101 g, with a maximum 175 g under good orchard management. 'Jinyan' has superior storage quality, it can be stored well for more 2 months at room temperature (20°C) and the shelf life is more than 10 days. In the Wuhan region, 'Jinyan' budbreak occurs in early March, and flowering begins about 26 April, and rapid expansion period of fruit is from early May to late June. The best harvest time of 'Jinyan' is from late October to early November when soluble solids content is about 9%.

159 [h026 / b000](#)

Title Kiwifruit quality standards
Author B. Pancino, D. Ferrucci, N. Passeri, P. Grassi and G. Cassoni
Citation ISHS Acta Horticulturae 913:535-538.2011.
Keywords cultivation technique; organic agriculture; integrated production; sale value

Abstract

An economic evaluation of the economic outputs of kiwifruit organic, integrated and conventional production systems was undertaken to compare the three cultivation methods from a market and farm management point of view. A case study was used; yield, fruit size, qualitative characteristics

and prices obtained from the three different systems were obtained. Outcomes of the comparison between organic, integrated and conventional production systems will provide input to formulate some future management and market decisions.

160 [h026 / b000](#)

Title Monitoring of 'Hayward' (*Actinidia deliciosa*) fruit ripening in North-West Italy

Author S. Pellegrino, F. Costamagna, M. Noferini and G. Costa

Citation ISHS Acta Horticulturae 913:665-669.2011.

Keywords vis/NIR spectroscopy; IDA; sensory analysis; soluble solids content; flesh firmness

Abstract

The ripening stage at harvest affect fruit quality at consumption and storage life. When harvest is performed early, fruits loose quality and may undergo a precocious softening during storage. In North-western areas of Italy (Piedmont region) latitude imposes harvest period that might compromise between a minimum ripening stage at harvest and the risk of yield losses due to fall early frosts and this situation further complicate the definition of the proper harvest time. To assess more precisely the harvest, a monitoring of the maturation and ripening evolution of 'Hayward' fruits was performed with both destructive and non-destructive methods. Fruits characterized by different ripening stage were also used for a sensory analysis to characterize and evaluate fruit organoleptic quality.

161 [h026 / b006](#)

Title Postharvest application of 1-methylcyclopropene (1-MCP) extends shelf life of kiwifruit

Author C.M. Cantin, D. Holcroft and C.H. Crisosto

Citation ISHS Acta Horticulturae 913:621-626.2011.

Keywords *Actinidia deliciosa*; firmness; postharvest quality

Abstract

The role of postharvest application of 1-methylcyclopropene (1-MCP) in the softening of 'Hayward' kiwifruit under different cold storage conditions was investigated. 1-MCP treated fruit (0.0, 0.5, 1.0 $\mu\text{l L}^{-1}$) were kept in cold storage (1°C) up to 6 months before ripening. Different 1-MCP application times were also tested in this trial (12 and 24 h). Effect of 1-MCP under ethylene-free

atmosphere and under ethylene contaminated atmosphere during storage was investigated. Under both conditions, 1-MCP treatment significantly delayed the rate of fruit softening during cold storage. Firmness out of cold storage was significantly increased by 1-MCP treatments. Moreover, the number of days of shelf life at 20°C (after 4 and 6 months of cold storage at 1°C) needed by 'Hayward' kiwifruit to reach a flesh firmness ≤ 10 N was significantly increased by 1-MCP postharvest treatment. These data show that 1-MCP treatment recommendations for an optimal result depend on both the length of cold storage as well as ethylene contamination of the atmosphere during storage.

162

[h026 / b000](#)

Title Postharvest volatile treatments and preharvest elicitor applications reduce ripe rot disease incidence in 'Hort16A' kiwifruit

Author K.V. Wurms, A. Ah Chee, T. Reglinski, J.T. Taylor, M.Y. Wang, E.N. Friel and R. Chynoweth

Citation ISHS Acta Horticulturae 913:481-487.2011.

Keywords *Actinidia chinensis*; *Cryptosporiopsis actinidiae*; elicitors; volatiles

Abstract

Ripe rot, caused by *Cryptosporiopsis actinidiae*, can cause significant loss of yellow-fleshed *Actinidia chinensis* 'Hort16A' kiwifruit fruit in long-term storage. Disease incidence can be reduced by storage of fruit in air rather than in controlled atmosphere; however, there is no other current form of disease control and alternative measures are sought. Fourteen volatiles, sourced from two commercial kiwifruit cultivars, *Actinidia deliciosa* 'Hayward' and 'Hort16A', were tested for in vitro fungitoxicity to *C. actinidiae*. (E)-2-hexenal and ethyl hexanoate completely inhibited mycelial growth at 6 mg/Petri dish. These volatiles also reduced the incidence of *Cryptosporiopsis* rots relative to that in control fruit, when used as fumigants in bins containing 360 fruit. However, fruit in the ethyl hexanoate atmosphere suffered skin breakdown leading to increased incidence of *Phomopsis* sp. side rots. Butanoate concentration, which is associated with ripening/softening, also increased more rapidly after ethyl hexanoate treatment. In field studies, six different elicitors were applied on multiple occasions preharvest, for two seasons. Ripe rot incidence was reduced by 50-75% in fruit treated with salicylate-based compounds but was less affected by methyl jasmonate. This may suggest resistance to ripe rots in kiwifruit is mediated by salicylate-responsive rather than jasmonate-responsive pathways.

163 [h026 / b000](#)

Title Prevention and prediction of kiwifruit softening
Author T. Cooper, K. Sagredo, A. Mansilla and J. Streif
Citation ISHS Acta Horticulturae 913:583-585.2011.
Keywords *Actinida deliciosa*; fruit firmness; modelling

Abstract

Softening, specifically early softening, is the main quality problem for export of Chilean kiwifruit. A four-year multifactorial project was carried out to determine the main factors involved in softening, as well as developing a method that could be used for prediction and control. Different trials were performed to determine the influence of growing conditions and the most important fruit attributes on softening susceptibility of kiwifruit cultivated in different climatic areas in Chile. Pre- and postharvest handling techniques, including calcium applications, were also evaluated to identify their effect on quality. Fruit were harvested at 6.2-6.5% soluble solids content (except for maturity effects), and kept under the same storage conditions. Every fifteen days samples were taken to determine softening (number of days elapsing until fruit reached 18 N firmness). Softening did not depend on any particular factor but on a conjunction of growing conditions and vine management practices. Maintenance of fruit firmness was assisted by management that promoted moderate vigour, adequate fruit and plant exposure to light, caused a reduction in competition between fruit and vegetative growth, and high fruit Ca/N ratio. Fruit size, time of harvest, and position on the vine were also important factors. Postharvest handling challenge for Chilean kiwifruit exporters that can be overcome through rigorous temperature management, controlled atmosphere, stringent control of fruit decay and ethylene control. A successful mathematical model to forecast early kiwifruit softening was developed over the last three years of research. Initially, three climatic groups were determined from growing areas in Chile. In each cluster, orchard, plant and fruit variables were evaluated in nine orchards. From these data, two principal components (PC) or synthetic variables (orchard and plant component) were obtained using a PC analysis. Subsequently, a multiple lineal regression in function of the PC was used to predict period of time to reach 18N. This model is presented.

164 [h026 / b006](#)

Title Study of anaerobic metabolism of kiwifruits in ULO, LO, or regular CA at room temperature

Author R. Botondi, V. Russo and F. Mencarelli
Citation ISHS Acta Horticulturae 913:567-574.2011.
Keywords kiwifruit; ethanol; acetaldehyde; PDC; ADH; LDH; GPT

Abstract

Kiwifruits were picked at an early ripening stage with firmness of 105 N and soluble solids content (SSC) of 6 °Brix. Fruits were placed in air (CK), ULO (ultra-low oxygen) with 0.25% O₂, LO (low oxygen) with 1% O₂, or regular CA (controlled atmosphere) 2% O₂ + 5% CO₂, all maintained at 20°C and 90% relative humidity (RH). After 19 days, fruits were removed from the atmospheres to SL (shelf life) in air at 20°C for 12 days. Kiwifruit kept in the modified atmospheres produced little ethylene and had reduced respiration during the atmosphere treatments while control fruit showed a typical climacteric curve. At the time of shift to SL, kiwifruit in ULO showed reduced rise of both ethylene, and respiration compared to LO and CA fruit. Softening occurred during the atmosphere treatment but fruit in ULO were firmer than in other treatments. Control fruit softened rapidly and continuously. During SL, atmosphere treated fruits did soften but after 19 days they were slightly firmer than control fruit. PDC (pyruvate decarboxylase), lactate dehydrogenase (LDH), and ADH (alcohol dehydrogenase, for the reaction ethanol to acetaldehyde) activities in atmosphere-treated fruits were low but two times higher than control fruit during storage; at the time of shift to SL, there was a large, rapid, burst for PDC and LDH while, slightly later, ADH increased, at the same extent. Control fruit showed a much lower increase in enzyme activities and the increase was delayed compared with atmosphere treatments. Ethanol increased initially at the time of the shift and then declined while acetaldehyde continued to rise. The potential role of anaerobic respiration on rapid softening of kiwis during SL is discussed.

165 [h026 / b000](#)

Title Temporal and spatial changes of chlorophyll fluorescence characteristics of postharvest kiwifruit (*Actinidia deliciosa* 'Changan 4')

Author X.M. Guo, G.X. Wang and R.F. Gao

Citation ISHS Acta Horticulturae 913:559-566.2011.

Keywords carotenoid; maximal PS II quantum yield; effective PS II quantum yield; coefficient of photochemical quenching; coefficient of non-photochemical quenching; apparent electron transport rate

Abstract

Chlorophyll fluorescence characteristics of kiwifruit (*Actinidia deliciosa* (A. Chev.) C.F. Liang et A.R. Ferguson 'Changan 4') at postharvest were studied. Photosynthetic pigment concentrations in outer pericarp (OP), inner pericarp (IP) and axile placenta (AP) were determined and maximal PS II quantum yield (Fv/Fm), effective PS II quantum yield (Y(II)), coefficient of photochemical quenching (qP), coefficient of non-photochemical quenching (NPQ), apparent electron transport rate (ETR) were compared. Contents of chlorophyll (Chl) a, Chl b, Chl a+b and carotenoid (Car.) decreased and the proportion of light-harvesting Chl to reactive center Chl increased as indicated by increasing Chl a/b in the same tissue zone with storage; content of the pigments reduced in the orders of OP, IP and AP while the proportion increased as indicated by decreasing Chl a/b in the same order of tissue zone in the same stage. Except that Y(II), qP and ETR were all zero in AP and its peripheral part (PP), Fv/Fm, Y(II), NPQ, qP and ETR declined in the corresponding tissue zone with the progress of fruit ripening; along the long axis from the distal end to the base of the fruit in the same stage, the changing trend of these parameters were identical in OP and IP, while Fv/Fm and NPQ of PP and AP presented an upward trend after the first drop. And these parameters decreased in the order of OP, IP and AP in the same stage. It is concluded that OP and IP of the fruit still have a certain degree of photochemical activity after harvest.

166

[h026 / b006](#)

Title The potential benefits from storage of 'Hort16A' kiwifruit in controlled atmospheres at high temperatures

Author N. Lallu, J. Burdon, D. Billing, P. Pidakala, K. McDermott and G. Haynes

Citation ISHS Acta Horticulturae 913:587-594.2011.

Keywords *Actinidia chinensis*; chilling injury; degreening; disorders; rots; energy use; softening

Abstract

The storage life of 'Hort16A' kiwifruit is limited by softening and chilling disorders when stored at 1.0-1.5°C. Chilling disorders are most prevalent in fruit harvested when flesh colour is >103 °hue, even when fruit have been degreened at 5°C before storage. Chilling disorders may be avoided by using higher storage temperatures, which may also reduce energy use during storage. The objective of this study was to determine whether 'Hort16A' fruit can be stored at high temperatures by using controlled atmospheres (CA) of 1.6% O₂ with 2, 5 or 10% CO₂ to retard softening and disorder development. Storing fruit harvested at 6.2 kgf when not fully degreened directly at 7°C in CA delayed softening compared with that

of fruit degreened at 5°C in air and then stored at 1°C in air; firmness four weeks after harvest was 3.6 kgf and 1.6 kgf, respectively. After 12 weeks of storage, all fruit were approximately 0.6 kgf. There was no significant difference in the softening of fully degreened fruit when stored at 7°C in CA or 1°C in air. There was no significant effect of CO₂ concentration on softening, but the highest incidence of rots and disorders was in fruit held in a CA with 10% CO₂. Chilling disorders were absent in fruit stored at 7°C, but present at up to 3-5% in fruit stored at 1°C. It is concluded that it is possible to store 'Hort16A' fruit at 7°C by using CA (1.6% CO₂ with 2% CO₂) to retard softening with no detrimental effects to fruit quality compared with that of fruit stored at 1°C in air. The potential benefits are a reduction in chilling disorders and energy use, plus for fruit that require degreening off the vine, greater firmness retention early in storage. To achieve energy savings, the production of respiratory heat at 7°C in CA should be comparable to the rate at 1°C in air. If so a difference in energy use of 35% is possible.

167

[h026 / b000](#)

Title Titrateable acidity in kiwifruit, a comparison of different methods of analysis
Author K.B. Marsh, M. Sullivan and T.G. Thorp
Citation ISHS Acta Horticulturae 913:657-660.2011.
Keywords juice; tissue; millequivalents; total acids

Abstract

Kiwifruit vary in acid content between 0.6 and 1.5% and the acid-sugar balance is an important characteristic governing the consumer preference. It is a common practice to analyse titrateable acidity (TA) but we are aware of two different approaches. Juice can be squeezed from the fruit so that TA in grams per 100 g juice is reported, or alternatively a measured weight of tissue can be sampled. TA measurements in fruit grown in warm climates have also been shown to drop quickly (up to 50%) after only 1-2 months in storage. This could be a feature of either the methodology used (juice titration) or of the climate. We therefore compared titrateable acidity measurements from juice and tissue samples from the same fruit in several different orchards in Italy and New Zealand. Although, juice TA declined by up to 30% after 4 weeks' storage in one orchard, in a few orchards an increase in juice TA was observed during the same storage period. By contrast, the results for TA using a measured amount of tissue were much more stable and showed no significant difference after storage. It seems that the pronounced drop in titrateable acidity reported in warm climates is a feature of the TA of the juice sample only. We

recommend titrating a fixed amount of tissue as this measurement has previously allowed correlation with fruit taste and with orchard variations such as dry matter.

168 [f008 / b005; b006](#)

Title Hot water dips and modified atmosphere packaging affect postharvest decay in cherry tomatoes

Author S. D'Aquino, M. Schirra, A. Palma, F. Mura and V. Balmas

Citation ISHS Acta Horticulturae 914:283-286.2011.

Keywords cherry tomato; decay; hot water dip; modified atmosphere packaging; storage

Abstract

Cherry tomatoes (*Solanum lycopersicum*) 'Uber' and 'Dorotea', respectively a 'nor' and a conventional type, were either subjected to hot water dip (HWD) for 2 min at 40, 45 or 50°C, or not dipped (control). Following treatments tomatoes were placed in polystyrene trays and sealed either with a laser-perforated film (OTR 3000 cm³ O₂/m², 24 h) or with the same film not subjected to laser perforation but punctured 40 times by a 2-mm-diameter needle, or left unwrapped. Fruit were then stored at 20°C and 60-65% RH and checked for decay after 7, 10 or 15 days. HWD caused severe cracking in 'Dorotea' tomatoes: two hours after the treatments about 6, 8 and 23% of fruit dipped in water heated at 40, 45 and 50°C, respectively, exhibited visible cracks. Although only visibly sound fruit were packaged, 'Dorotea' tomatoes continued to crack during storage, especially those dipped at 50°C and wrapped with the laser perforated film. In contrast, in 'Uber' tomatoes cracking incidence was negligible. Decay increased with storage time, but was also significantly affected by cultivar, HWD and film wrapping. After 7 days of storage decay was negligible in both cultivars, while after 10 and 15 days decay incidence in 'Dorotea' and 'Uber' increased to 6-12 and 2-5%, respectively. Decay incidence was highest in packages sealed with the laser perforated film, while it was lowest in unwrapped fruit. HWD effectively reduced decay in 'Uber' tomatoes, and its activity was correlated positively with temperature; in contrast in 'Dorotea' the best decay control was achieved in fruit dipped in water at 45°C. After 15 days of storage 'Dorotea' tomatoes dipped in water at 50°C and wrapped with the laser perforated film and Control 'Dorotea' tomatoes reported the highest decay percentage (>30%), while in 'Uber' tomatoes subjected to the same treatment only 3% of decay occurred.

169 [f008 / b000](#)

Title Occurrence of tomato bacterial spot disease in Saudi Arabia, and effect of salicylic acid treatments on disease incidence

Author Y.E. Ibrahim and M.A. Al-Saleh

Citation ISHS Acta Horticulturae 914:47-51.2011.

Keywords salicylic acid; foliar application; *Xanthomonas campestris*pv. *vesicatoria*

Abstract

Symptoms of a bacterial disease caused by *Xanthomonas campestris*pv. *vesicatoria* were observed on tomato plants growing in Al-Kharj area of Saudi Arabia. Symptoms included irregular yellow-necrotic areas on tomato leaves and spotting on the stem. Five bacterial isolates were isolated from the infected tomato seedlings. The pathogen identity was confirmed biochemically, and physiologically, hypersensitive reaction occurred in tobacco plants and pathogenicity test was conducted. All concentrations tested of salicylic acid (SA) had inhibitory effects against *X. c.*pv. *vesicatoria* under laboratory conditions. Application of SA at 1.5 ppm reduced severity of bacterial leaf spot of tomato.

170 [f008 / b000](#)

Title Putative role of antioxidant activity of high pigment tomato cultivars in resistance against *Botrytis cinerea* post-harvest infection

Author C. Pane, M. Parisi , M. Zaccardelli, G. Graziani and V. Fogliano

Citation ISHS Acta Horticulturae 914:429-432.2011.

Keywords lycopene; carotenoids; grey mold; *Botryotinia fuckeliana*; reactive oxygen species; ROS scavenger; *Lycopersicon esculentum*

Abstract

Grey mold caused by the fungus *Botrytis cinerea*, an amorphic form of *Botryotinia fuckeliana*, represents one of the main causes of decay in harvested tomatoes. Many studies revealed that fungal infection is associated with enhanced reactive oxygen species (ROS) generation. Therefore, ROS scavengers and antioxidant compounds were proposed to limit mycelia colonization in advancing of the plant tissue. Tomato fruit is a significant source of tetraterpenic antioxidants, such as carotenoids, including lycopene that is the most efficient antioxidant in the pulp. In this study, seven commercial “high pigment” (HP) cultivars of tomato were studied for fruit response to grey mold disease due to an artificial

post-harvest inoculum of *B. cinerea* conidia suspension. A traditional red (no HP) and a yellow genotype were used as reference control. Moreover, antioxidant activity and total carotenoids content in the berries were measured. Carotenoids content was well co-related better with I-AA than with S-AA. Pathogenicity assay showed a clear separation among same HP cultivars and controls. In particular, the yellow genotype resulted with higher levels of disease severity. Moreover, comparing all results, carotenoids content, S-AA and I-AA were resulted negatively related to *Botrytis* disease severity measured between the cultivars considered. This evidence showed the potential of HP tomato genotypes to constitute an important source of carotenoids for diet. Moreover, with regard to grey mold, the results confirmed the putative role of the antioxidant compounds in post-harvest tomato resistance.

171 [f035 / b000](#)

Title Characterization of argentine's globe artichoke (*Cynara cardunculus* [L.] Var. *Scolymus*) cultivars by post-harvest related traits

Author R. Rotondo, I.T. Firpo, S.M. García, F. López Anido, V.P. Cravero and E. Cointry

Citation ISHS Acta Horticulturae 942:473-478.2012.

Keywords pappus; phenols; dry matter; fiber; fresh and industry market

Abstract

In Argentina, since globe artichoke production is destined mainly to the fresh market, capitula are harvested, depending on cultivar and culinary uses, when maximum sizes are reached. In this contribution, primary and secondary order capitula of the cultivars 'Oro Verde FCA', 'Gauchito FCA', 'Esmeralda FCA', 'Gurí FCA', 'Estrella del Sur FCA' and 'Francés', were evaluated for traits related to quality: head weight and diameter, inner bracts color, pappus length, and contents of fiber, dry matter and phenols. Data were subjected to principal component analysis. For the first order capitula, the two principal components explained 78% of the variation, being head weight, diameter, content of dry matter and phenols associated to the first component (CP1) and pappus length, bracts color and fiber content to CP2. Cultivars 'Gauchito FCA' and 'Gurí FCA' presented a reduced pappus length, and high dry matter and phenols content, meanwhile 'Esmeralda FCA' showed intermediate dry matter content and the lowest values of phenols and pappus length. For the second order capitula, the first two principal components also explained 78% of the variation; but the phenols content was not important, being the CP1 associated to head weight, diameter, and dry matter content; and CP2 to pappus length and fiber content. 'Gurí FCA' was the best cultivar, showing the lowest values of fiber content and pappus length, and intermediate values of head

weight, diameter and dry matter content. 'Oro Verde FCA' was the poorest material. 'Gurí FCA' was selected for a double purpose use; that is, first order capitula for fresh market, and second order for industry.

172 [f035 / b000](#)

Title Characterization of phenolic acids and flavonoids in leaves, stems, bracts and edible parts of globe artichokes

Author G. Pandino, S. Lombardo , G. Mauromicale and G. Williamson

Citation ISHS Acta Horticulturae 942:413-417.2012.

Keywords cultivar; part of plant; antioxidant; polyphenols; HPLC analysis

Abstract

Since Roman times, the globe artichoke has been considered as a tasty vegetable with beneficial effects on human health. Nowadays, many studies have demonstrated that its health-promoting properties are related to the polyphenolic compounds present in the inflorescences (heads) and leaves. The aim of the present study was to evaluate the influence of cultivar and plant part on polyphenol content and profile. Field experiments were conducted on the Catania Plain (Sicily), a typical area for globe artichoke cultivation in Italy, utilizing three cultivars: 'Violetto di Sicilia', 'Tondo di Paestum' and 'Blanc Hyérois'. Our results show that a single class of polyphenols accumulated preferentially in specific parts of plants and their amount varied among cultivars. In particular, the leaves contained either the highest total measured polyphenols (TMP) content and flavonoid level (457.7 nmol/g of dry matter and 95% of the TMP, respectively), while the caffeoylquinic acids were more abundant in the floral stem (86% of the TMP). Concerning cultivars, 'Violetto di Sicilia' reached the highest polyphenol concentration in each head fraction, except in the receptacle. In contrast, the TMP for the receptacle was higher in 'Tondo di Paestum'

173 [f035/ b006](#)

Title Combined technologies to inhibit enzymatic browning and preserve quality of fresh-cut artichoke hearts

Author P. Gómez di Marco, P. Robles, J. Braun, F. Artés Hernández, J.A. Fernández and F. Artés

Citation ISHS Acta Horticulturae 942:385-390.2012.

Keywords *Cynara scolymus* L.; minimal processing; modified atmosphere packaging; antioxidant solutions; phenolics; sensory quality

Abstract

During the last years, consumers demand convenient products, easy to prepare and with high sensory and nutritional quality. Fresh-cut fruit and vegetables have been developed to satisfy that demand. The industry of that sector is highly competitive and continuously needs technological solutions. Minimally processed artichokes are a very interesting product, but after cutting heads are highly susceptible to enzymatic browning, resulting in loss of nutritional and sensory quality. This research studied the effect of two active modified active packaging (MAP) (air as control) combined with two antioxidant solutions (chlorinated water as control) to prevent browning and slow down quality loss in purple artichokes (*Cynara scolymus* L. 'Salambo'). Heads were hand harvested and immediately air pre-cooled at 5°C. In a disinfected cold room at 5°C outer bracts were removed and top and bottom were cut. Obtained hearts were immersed in a chlorinated water solution (100 ppm Na ClO) for 1 min. Before packaging, the artichokes hearts were dipped for 3 min. into two different solutions: a) lemon juice (60% v/v) and b) oxalic acid (0.02% w/v) + ascorbic acid (1% w/v). Two hearts were placed in polypropylene (PP) baskets of 500 ml and thermally sealed at the top m thickness. Active MAPs were 4 kPa μ with an oriented PP film of 35 O₂ + 20 kPa CO₂ + 76 kPa N₂ and 80 kPa O₂ + 20 kPa N₂. After 6 d at 5°C weight loss, sensory quality and phenolics content were evaluated. A whiteness index (WI) combining L*, a*, and b* parameters was calculated to analyse colour changes, the higher the index, the lower the browning. Sensory quality was acceptable for all the treatments. High O₂ MAP combined with lemon juice showed the highest WI. Total phenolics were better kept in high O₂ MAP combined with antioxidant solutions. The use of these substances under superatmospheric oxygen could be a good option for keeping overall quality of artichoke hearts up to 5 d at 5°C.

174

f035 / b000

Title Describing sensory characteristics of globe artichokes

Author C. Baty-Julien and A.B. Hélias

Citation ISHS Acta Horticulturae 942:427-431.2012.

Keywords descriptive quantitative analysis; organoleptic quality; sensory attributes

Abstract

Brittany is the main artichoke production area in France. Mainly two globe artichoke varieties are marketed: 'Camus' and 'Castel'. Commercial distinction is done between these two varieties but little is known about their sensory characteristics and more generally about sensory quality changes of artichoke. This study was conducted with the aim to develop a detailed sensory profile of artichoke and to characterize the organoleptic properties of these varieties. Descriptive sensory analysis was performed by a panel of ten assessors. A list of thirty descriptors relating to odour, texture and flavour of artichoke was developed by panel consensus after tasting and discussions. All hedonic terms were avoided. The panellists were trained to recognise characteristics related to descriptors in products and to quantify their intensity. Assessments of 'Camus' and 'Castel' were performed for three harvest dates, each variety has been evaluated five times by panellists. Analysis of variance on data shows significant differences between cultivars on nine descriptors out of 30: earth odor, firm, crunchy, fibrous, pasty, gritty, nuts flavour, butter flavour and bitter taste. Differences between varieties according to harvest dates are also identified. In order to communicate about sensory properties of artichoke varieties, it is necessary to select characteristics on which differences are robust between dates of harvest. The list of descriptors and the panel can also be used to know much about sensory variability of artichoke.

175

f035 / b006

Title Effects of dipping treatments on quality of fresh cut artichoke
Author N. Calabrese, M. Cefola, A. Carito, B. Pace, F. Baruzzi and S. Vanadia
Citation ISHS Acta Horticulturae 942:407-412.2012.
Keywords *Cynara*; storage; shelf life; panel test; microbial count

Abstract

This paper describes the effects of anti-browning dips on sensory characteristics and microbial load of fresh cut artichoke hearts.

The hearts of a globe and white artichoke (cultivar 'Madrigal') were obtained by cutting the stem, the head top and by removing the external bracts. They were immediately dipped for 90 s in two different water solutions: citric or lactic acid 1%. The dipping in tap water was used as control. After the treatment the artichoke hearts were washed, drained, packed in PE bags and stored at 4°C for 12 days; for each treatment 12 bags (three replicates for four storage periods) containing 6 artichokes hearts were prepared. Qualitative traits, microbiological counts and sensory characteristics were evaluated during cold storage. Dipping treatment in lactic acid inhibited the enzymatic browning and the increase in the microbial

population, allowing to obtain high quality fresh cut artichokes. Whereas dipping in citric acid solution, slightly delayed browning, but it did not result in substantial improvement of color evolution on cut surfaces compared to water dip control. As conclusions, lactic acid dipping maintained the sensorial attributes and controlled total aerobic bacterial population of fresh cut artichoke hearts. In this way it is possible to obtain a new healthy ready to eat (or to cook) product increasing the artichoke consumption.

176 [f035 / b003; b006](#)

Title Influence of cold storage and washing treatments on total polyphenols content in globe artichoke heads

Author M.G. Melilli, S.A. Raccuia, G. Panebianco, S. Scandurra and P. Di Blasi

Citation ISHS Acta Horticulturae 942:391-394.2012.

Keywords globe artichoke head; total polyphenolic acids; chilling temperature; processing procedure

Abstract

In order to prevent damages of perishable vegetables during storage it is necessary to maintain their nutritional value and organoleptic properties. Artichoke is very perishable because of its high respiratory activity and susceptibility to weight loss, decay and biochemical and physiological damages. To avoid postharvest disorders and extend shelf life, the use of different heads treatments and chilling temperatures could help to realize these goals. In this work, the total polyphenols changes of globe artichoke ('Violetto di Sicilia') heads during storage at two different temperatures (4°C and 8°C) and two washing treatments (distilled water and 2% ascorbic acid in distilled water) were investigated.

Half of the harvested heads without stems were washed with distilled water, the other half was washed with 2% ascorbic acid in distilled water. After 30 minutes of dipping the two washing solutions were removed and washed buds were placed inside perforated polypropylene food bags (five × bag) and stored at the two different temperatures for four weeks. At harvest and after every week of chilling storage for a total of five sampling, on 3 bags (experimental unit) heads weight (g) and total phenols ($\text{mg}_{\text{GAE}} \text{kg}^{-1}$ f.w.) were analyzed.

During the weeks of storage, a constant loss of head weight was observed. After four weeks of storage, averaged for washing medium, the weight of buds was reduced of 2.6% at 4°C and 4.7% at 8°C. At harvest total phenols resulted in $2158 \text{ mg}_{\text{GAE}} \text{kg}^{-1}$ f.w. In both temperatures, averaged for weeks of

storage, total phenols degradation appeared more marked in ascorbic acid solution than in water; this degradation was much more accentuated at 8°C than 4°C.

At 4°C, in both washing mediums, after two weeks of storage peaks of 3216 (water) and 2774 meq_{GAE} kg⁻¹ f.w. (ascorbic acid 2% in water) were observed.

177

[h026 / b006](#)

Title Beneficial effects of a pre-commercial application of SmartFreshsm (1-methylcyclopropene) on texture preservation and reduced weight losses of 'hayward' kiwifruit: potential commercial benefits of SmartFreshsm (1-MCP) for retarding ripening and extending the storage and shelf life of 'Hayward' kiwifruit

Author E. Sfakiotakis and I. Petkopoulou

Citation ISHS Acta Horticulturae 913:603-608.2011.

Keywords kiwifruit; 1-methylcyclopropene; SmartFreshSM; firmness; soluble solids content

Abstract

A pre-commercial application of SmartFreshSM (1-methylcyclopropene) was carried out in a coolstore, in Pieria, the main kiwifruit growing area of Greece, to determine the commercial benefits of the new technology for the Greek kiwifruit industry. The aim of this study was to evaluate under commercial storage conditions of kiwifruit whether SmartFreshSM (SF) shows the same effects found from previous pilot studies to extend the marketing period and to determine the commercial benefits of the application of SF technology. The study showed that the SF-treated fruit remained firmer than the control fruit, during storage and shelf life and consequently had an extended marketing period for wholesale and retail operations. However, during shelf life the SF-treated fruit resumed softening and by the end of the storage period had developed the melting flesh texture of eating-ripe kiwifruit. In terms of changes in soluble solids content, the SF-treated fruit reached, with no delay, by the end of the storage period a maximum soluble solids content no different to that of the control fruit. During the storage period the SF-treated fruit lost less weight (about 45%) than the control fruit. If we consider that weight losses are quantitative losses (loss of saleable weight) the above finding gives an important advantage in favor of SF technology.