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The Influence of Preharvest Practices and Postharvest Treatments on Sensory Characteristics of Fresh and Fresh Cut Produce

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ABSTRACT

Observation of consumer expectations regarding food quality provides the basic for any successful food production and marketing. This is also true for fresh fruits and vegetables which are increasingly valued as an important part of the diet. Traditional quality evaluation of fruits and vegetables is associated, primarily, with appearance attributes, such as size, shape, surface color and defects; tactile characteristics, such as firmness or hardness; and internal quality attributes, such as sugar and/or oil content, vitamins and internal defects and disorders. However, sensory attributes play an important role in a consumer's decision to purchase fresh or fresh-cut fruit or vegetables. Preharvest practices such as cultivation, growing system, soil type, and fertigation, as well as harvest practices, such as choice of the stage of maturity and postharvest treatments, such as controlled or modified atmosphere packaging, coating, and physical or physicochemical treatments may affect the sensory and flavour attributes of fresh and fresh-cut product. The goal of this mini review is to summarize the information that has been published during the last 4 years on preharvest practices and postharvest treatments that affect the sensory characteristics of fruits and vegetables, marketed as fresh, or fresh-cut products.

Keywords: CA, fruit, MAP, shelf life, storage, vegetable

Abbreviations: 1-MCP, 1-methylcyclopropene; **AVG**, aminoethoxyvinylglycine; **CA**, controlled atmosphere; **ETH**, ethephon; **LDPE**, low density polyethylene; **MAP**, modified atmosphere packaging; **PE**, polyethylene; **PET**, polyethylene terephthalate

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INTRODUCTION

Over the last half-century there have been many changes in the way fruits, vegetables and ornamentals are grown, stored and distributed. In a society where, increasingly, food is being seen as a source nutraceuticals, the nutritional value of fresh produce is coming under increasing scrutiny. Community concerns about the effects of poor diets on health are being reflected in campaigns to increase the consumption of fresh fruits and vegetables, and also of fresh-cut products. One of the key factors in achieving this is to provide fresh or fresh-cut produce of high quality and safety standards. Product quality is a complex issue, since it includes visual characteristics, physical properties such as texture, mineral and vitamin contents, and flavour and other organoleptic characteristics (Shewfelt 1999). Once produce is harvested, postharvest handling practices do not improve the quality attained in the field; they only slow the rate at which physiological and pathological deterioration occurs. Nevertheless, the appearance, flavour and freshness of a product can play a leading role in a consumer's decision to purchase it and can influence their perception of it by other senses (Peneau *et al*. 2006; Pery 2006).

Perceptions of what constitutes good quality vary between countries, regions and individuals. They can also be affected by culture, experience and personal preferences. The overall quality attributes that are important to packers, transporters, and retailers are often quite different from those that matter to consumers (Watkins and Ekman 2005). However, sensory quality is important for consumer satisfaction and influences further consumption. The key to increasing consumer consumption of fresh fruits and vegetables and fresh-cut products, without loss of grower income, lies in providing produce of superior flavour, which it retains during prolonged storage and extended shelf life.

Preharvest practices such as cultivation, growing systems, soil type or fertigation; harvest practices, such as choice of right stage of maturity; and postharvest treatments,

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such as grading, packing, controlled or modified atmosphere packaging, coating, and physical or physicochemical treatments may affect the flavour and other sensory attributes of fresh and fresh-cut products. The goal of this mini-review is to present examples of several aspects that have been addressed in papers published during the last 4 years, regarding preharvest practices and postharvest treatments that help to determine the sensory characteristics of fruits and vegetables marketed as fresh or fresh-cut products.

PREHARVEST PRACTICES

Achievement of the best potential postharvest quality and shelf-life of fresh fruits and vegetables depends on the conditions and events before harvest: everything from the cultivar to soil type and fertigation practices, as well as weather conditions and pest control programmes, affects the quality of harvested produce and its sensory properties.

Virtually all postharvest quality factors are genetically controlled and can differ among varieties, therefore, from a quality standpoint, cultivar selection may be an important management decision in crop production (Hampson and McKenzie 2006). Sinesio *et al.* (2007) found that for most sensory characteristics of tomatoes grown in open fields, the greatest variation was caused by differences in genotypes, suggesting that there was considerable degree of genetic diversity. Minor effects were attributed to year of harvest and differences between experimental fields. A new mandarin cultivar currently designated as selection LB8-9 has been evaluated by a fruit taste panel for consumer, acceptance in comparison with 'Sunburst' and 'Minneola' mandarins, and it achieved a better acceptance score than 'Minneola' after 50 d of storage at 4°C. Overall, LB8-9 has good potential as a new fresh fruit for the consumer, and no serious problems were noted under typical postharvest handling (Dou and Gmitter 2007). The overall eating quality of blueberry fruit depended on the cultivar, it was best correlated with flavour scores followed by sensory scores for intensity of juiciness, bursting energy, sweetness, and acceptability of appearance (Saftner *et al*. 2008). Apple (*Malus domestica* Borkh.) cultivars differ in their aroma and composition of volatile acetates in their fruit flesh and peel. Cv. 'Fuji' flesh contains substantial levels of 2-methyl butyl acetate (fruity banana-like odour), while the flesh of cv. 'Granny Smith' apples lacks this compound. Granny Smith apples accumulate mainly hexyl acetate (apple-pear odour) in their peel. Feeding experiments indicated that 'Fuji' apples were able to convert hexanol and 2-methyl butanol to their respective acetate derivatives *in vivo*, while 'Granny Smith' apples could only convert exogenous hexanol to hexyl acetate (Holland *et al*. 2005).

Soil type was found to affect sensory attributes of freshly harvested produce. Clay soil appeared to have some advantages over sandy loam soil in producing cantaloupe fruits with superior sensory quality attributes (Bett-Garber *et al*. 2005). On the other hand, Thybo *et al.* (2005a) reported that the type of growth medium (soil or rockwool) had little or no effect on the sensory characteristics of tomato fruits (*Lycopersicon esculentum* Mill.). However, for the characteristics related to texture (crispness and firmness), soil-grown tomatoes were slightly but significantly softer than the rockwool-grown ones (Thybo *et al*. 2005a).

Three litchi (*Litchi chinensis* Sonn.) 'Mauritius' orchards were compared, that differed in planting distances and the routine pruning practices that followed each growing season. The quality and the consumer acceptability of fruit picked from the orchard that had overlapping canopies because short planting distance and lack of routine pruning after each growing season were much lower than those of fruit from the other two orchards, in which routine pruning was practised (Sivakumar and Korsten 2007). Neither sensory quality attributes nor the composition of volatile compounds was affected by planting density of apples (*Malus* x *domestica* Borkh.) cultivars (Thybo *et al*. 2005b). The bioregulators aminoethoxyvinylglycine (AVG), ethephon (ETH), and 1-methylcyclopropene (1-MCP) were applied at various times, before or after harvest to 'Scarletspur Delicious' and 'Gale Gala' apple trees (*Malus* x *domestica*), and sensory scores for 'Scarletspur Delicious' were more strongly affected by bioregulators than were 'Gale Gala' apples (Drake *et al*. 2006).

Irrigation is also a very important preharvest factor that affects quality and sensory attributes of fresh produce; strawberry fruit from deficit irrigated plants had better taste-related and health-related properties than water-treated control fruit (Terry *et al*. 2007). Modifications of fruit quality that resulted from a long-term salt stress during 4 months were studied in two strawberry cultivars differing in their sensitivity to salinity. The more tolerant cv. 'Korona' exhibited an increase of reduced glutathione and a better fruit taste, where the taste of salt-stressed fruits of cv. 'Elsanta' was significantly impaired (Keutgen and Pawelzik 2008).

Organic farming has become one of the fastest growing segments of world agriculture. Results of postharvest quality evaluation and sensory tests on organic and conventional 'Pei-chiao' and 'Fromosana' bananas revealed that organic farming yielded a better mouth-feel, and increased the total soluble solids contents of autumn 'Pei-chiao' and winter 'Formosana'. However, in comparison with conventionally grown fruit, the shelf life was shorter for organic summer and autumn bananas, and longer for organic winter and spring bananas (Chang *et al*. 2007). do Amarante *et al.* (2008) assessed the yield and fruit quality of apples produced with a conventional and an organic production systems in southern Brazil, and could not detect any significant differences between fruits from the two production systems with respect to the fruit attributes of taste, flavour and texture, for either cultivar. In comparison with organic grapefruit, conventional grapefruit was better coloured and higher in lycopene, and the juice was less tart, lower in the bitter principle naringin, and better accepted by the consumer panel. However, in contrast, the organic fruit had a commercially preferred thinner peel, and the juice was higher in ascorbic acid and sugars and lower in nitrate and the medication interactive furanocoumarins (Lester *et al*. 2007).

HARVEST PRACTICES

After harvest, quality cannot be improved, only maintained; therefore it is important to harvest fruits, vegetables, and flowers at the proper stage and size and at peak quality. Immature or over-mature produce may not last as long in storage as that picked at proper maturity.

Harvesting papaya fruit at different stages of maturity altered their postharvest physiology, and early harvesting reduced fruit quality but did not make it unacceptable for consumption (Bron and Jacomino 2006). On the other hand, Kreck *et al.* (2005) found general acceptance of fresh overripe plum (*Prunus domestica* L.) picked at the end of the harvesting period; although statistical correlations between analytical and sensorial parameters were mainly found between sweetness and soluble dry mass and between the attributes sourness/unripe/green/astringency and total acidity, sweetness and sourness were the deciding factors in determining the general acceptability of the fruits by consumers. Apple aroma volatiles and sensory quality were significantly affected by harvest date when it was based on the fruit colour; fruit of higher red colour grading had higher concentrations of aroma volatiles than those of lower grading (Thybo *et al*. 2005b). Muskmelon varieties should be harvested when light yellow with some green areas, in order to obtain the best quality, aroma and other sensory attributes, and also longer shelf. The main flavour components detected were esters which increased 1.0-15-fold from unripe to ripe and overripe stages (Senesi *et al*. 2005).

Fresh-cut melon quality can also be affected by the stage of maturity at harvest. Fresh-cut chunks of orange-fleshed honeydew ('Honey Gold', 'Orange Dew', 'Temptation' and three breeding lines), a green-fleshed honeydew ('Honey Brew') and an orange-fleshed cantaloupe ('Cruiser') harvested at commercial and full-slip maturities, were compared after storage in air for about 2 weeks at 5°C. Consumers liked the flavour, texture, sweetness and overall eating quality of the orange-fleshed honeydew genotypes as well as or better than those of cantaloupe and green-fleshed honeydew (Saftner *et al*. 2006).

POSTHARVEST PRACTICES

Fresh fruits, vegetables, and flowers must be in excellent condition and of top quality if maximum shelf life is to be achieved. The best possible quality of any commodity is found at the moment of harvest, and that is when shelf life begins. The most important goals of postharvest practices are to maintain the keeping quality of fresh and fresh-cut produce during prolonged storage and marketing.

Modified atmosphere packaging (MAP)

Modified atmosphere packaging involves the modification of the head space gas in a package in order to prolong the shelf life of the product it contains. The success of MAP depends on the packer's ability to prepare the product correctly, and to control the concentrations of head space gas within the desired limits.

The effects of MAP techniques for extending the shelf-life of fresh-cut jackfruit (*Artocarpus heterophyllus* L.) kept under low temperature conditions were investigated for quality and sensory evaluation (Saxena *et al*. 2008). On the basis of sensory quality attributes, the shelf-lives of pre-treated jackfruit packaged in gas-mixture-flushed polyethylene (PE) bags, in polyethylene terephthalate (PET) jars with a silicon membrane window, and in PE bags were 35, 31 and 27 days, respectively. Litchi (*Litchi chinensis* Sonn. cv. 'Mauritius') fruit stored in MAP (17.0% O_2 and 6.0% CO_2) retained colour and maintained excellent eating qualities during long-term storage (Sivakumar and Korsten 2006a), and similar results were found for litchi fruit cv. 'McLean's Red' (Sivakumar and Korsten 2006b). Treating 'Conference' pear cubes for processing with ascorbic acid at 10 g/L and calcium chloride at 5 g/L, followed by packaging in an atmosphere of 2.5 kPa O_2 + 7 kPa CO_2 preserved the overall sensory shelf life without significant changes, in comparison with untreated freshly prepared samples (Soliva-Fortuny *et al*. 2007).

Coating

Edible coatings can provide an alternative for extending the postharvest life of fresh fruits and vegetables. Semperfresh™-coated and uncoated hardy kiwifruit (*Actinidia arguta* [Siebold & Zucc.] Planch. Ex Miq) fruit were evaluated according to hedonic scale by a consumer sensory panel (Fisk *et al*. 2008), and the consumer test indicated that both coated and uncoated fruit were well liked. These results provide important information regarding the ripening physiology of 'Ananasnaya' hardy kiwifruit and indicate that edible coatings may be an alternative to costly low-vent packaging for reducing moisture loss and extending storage life of fresh fruit. Mango fruits were treated with 2% chitosan solution, or with 2% chitosan containing 1% of tea polyphenols (TP-chitosan), and their sensory quality was significantly better when coated with TP-chitosan than with chitosan alone (Wang *et al*. 2007). These results suggested that treatment with chitosan containing TP offered high potential for shelf-life extension of mango fruit. The sensory analyses of table grapes treated with grapefruit seed extract and chitosan revealed beneficial effects in terms of delayed rachis browning and dehydration, and maintenance of the visual quality of the berry without impairment of taste or flavour (Xu *et al*. 2007). Coating tomato fruit with edible alginate or zein was found to be an effective means for delaying the ripening process during postharvest storage, and, in turn, it maintained tomato quality and acceptability by consumers (Zapata *et al*. 2008). Porat *et al*. (2005) reported that 'Mor' mandarins that were coated with a modified wax formulation containing only half the amount of shellac present in commercial wax formulations, had significantly improved sensory attributes, mainly because of reduced development of off-flavour. Similar results were reported recently for naval orange fruits coated in wax. Ethyl butanoate, ethyl hexanoate, and four constituents with uncertain identification were aroma-active compounds that increased, while limonene decreased in amount to a greater degree in the packed fruit and may be at least partially responsible for the observed flavor changes (Obenland *et al*. 2008). Fallik *et al*. (2005b) recommended use of a commercial polyethylene-based wax that contained very little or no-shellac, which restricts gas exchange through the rind layer. After 7 days at 1°C plus 4 days at 20°C, the sensory analyses of 'Crimson' seedless table grapes coated with *Aloe vera* gel revealed beneficial effects, without any impairment of taste, aroma, or flavour (Valverde *et al*. 2005).

Controlled atmosphere (CA)

Controlled atmosphere refers to maintenance of a low-oxygen (O_2) and/or high-crbon dioxide (CO_2) atmosphere in the container or airtight enclosure holding the product. The atmosphere is "controlled" by a sequence of measurements and corrections throughout the storage period and is used in conjunction with appropriate refrigerated storage and distribution.

Sweet potato roots were stored under a continuous flow of zero or 1-kPA O_2, or air, to study the effects of short-term exposure to low O_2 on their physiological responses and quality (Imahori *et al*. 2007). Low-O_2 treatments increased the soluble solids content, and weak off-odours were detected by olfactory evaluation in roots stored under 0% O_2. The intensity of off-odours increased as a result of the increasing concentrations of acetaldehyde and ethanol in the roots during storage. Ethanol concentrations were higher than those of acetaldehyde, which remained low during storage in 1% O_2 and air but increased greatly in roots stored at 0% O_2 (Imahori *et al*. 2007). Holding wild strawberry fruits (*Fragaria vesca* L.) in CA containing 10 kPA of CO_2 and 11 kPa O_2 efficiently prolonged the shelf life by maintaining the quality parameters within acceptable values, without significantly modifying consumer acceptance (Almenar *et al*. 2006).

An alternative method of slowing ripening of fruits or vegetables after harvest is by exposing them to 1-methylcyclopropene (1-MCP), which inhibits ethylene action (Blankenship and Dole 2003). 1-MCP (625 nl/L) and CA-stored (CA; 2.0-2.5 kPa CO_2, 1.8-2.0 kPa O_2) 'Royal Gala' apples were preferred by consumers in all trials, indicating that both treatments can maintain the preferred textural characteristics of the fruit, especially during long-term storage (Moya-Leon *et al*. 2007). Moya-Leon *et al* (2006) also investigated the effects of long-term storage with 1-MCP under CA on aroma production and consumer acceptance of 'Packham's Triumph' pears. After 2 months of storage, pears kept under regular cold storage developed the highest content of volatile compounds and also the highest odour value, and were preferred by sensory panelists, whereas CA storage and 1-MCP treatment reduced the production of aromatic volatiles by the fruit. Hexyl acetate with fruity notes was found to be the main contributor to the aroma of the pears, followed by butyl acetate and pentyl acetate, while alcohols showed a poor contribution. Nevertheless, after a longer storage period, pears treated with 1-MCP or stored under CA conditions recovered their capacity for volatiles production with odour activity, and the panelists preferred the 1-MCP-treated over the CA-stored fruit.

The effect of CA on sensory quality of vegetables was also tested (Renquist *et al*. 2005). Sensory assessment of green asparagus (*Asparagus officinalis*) indicated that spears held in CA for 6 days had similar flavour and acceptability to those held in air for 1 day.

Physicochemical treatments

Inhibition of physiological or/and pathological deterioration of fresh harvested produce by a combination of any types of physical, chemical or environment-friendly chemical methods is called 'physicochemical' treatment.

Hypobaric (low-pressure) storage offers considerable potential as a method to prevent postharvest loss of freshly harvested produce. The effects of hypobaric storage on the biological characteristics of green asparagus were compared with those refrigerated and room-temperature storage. Hypobaric storage clearly improved sensory quality and delayed the post-harvest senescence process of asparagus (Li *et al*. 2006). Litchi fruits which are highly susceptible to pericarp browning were peeled and stoned, and the arils were treated with anti-browning agents (cysteine, ascorbic acid or 4-hexyl resorcinol) along with osmo-vacuum dehydration (OVD) (sucrose syrup for 10 min at 570 mmHg vacuum followed by a relaxation of 10 min at atmospheric pressure) and stored at 4°C (Shan and Nath 2008). The combination of treatment with anti-browning agents and by osmo-vacuum dehydration was found to be most effective in preventing the changes in litchis, and the samples were acceptable up to 24 days, whereas the samples that received only OVD treatment lost acceptability because of poor colour after 16 days of refrigerated storage, as compared with 8 days for the control samples, which were dipped in water for 10 min.

Ozone is a disinfectant that can be applied to produce either by direct contact or by indirect contact through washing with recycled water that contains ozone. Treating carrots with ozone stimulated production of the stress volatiles ethanol and hexanal to levels greater than those in the controls, immediately after a 4-day exposure to ozone at 1000 nL/L, but this effect diminished with increasing storage time (Forney *et al*. 2007); sucrose concentrations were reduced, but terpene concentrations were increased. In general, the prestorage-applied ozone concentrations reduced carrot quality and therefore are not likely to be of commercial value. Aguayo *et al.* (2006) examined the effects of a flow of humidified ozone enriched air (O_3 at 4 µL/L) on the sensory quality of whole and fresh-cut tomatoes stored for up to 15 days at 5°C. They found enhanced sugar (fructose and glucose) and organic acid (ascorbic and fumaric) contents in the O_3-treated fruit, which retained a good appearance and overall quality in the slices, but with reduced aroma. Ozone did not cause any damage or off-flavour in either sliced or whole tomatoes.

The overall quality of fresh harvested strawberries immersed in putrescine was improved in terms of properties evaluated by a taste panel; this was attributed mainly to the increased rate of titratable acidity and reduced dry matter content (Khosroshahi *et al*. 2007).

The effects of postharvest irradiation with visible light and UV-B radiation on several sensory related properties were measured in 'Aroma' apples and the relationships between these properties were evaluated (Hagen *et al*. 2007). The results suggest that postharvest irradiation can be utilized to improve the health value and colour appearance of apples without changing important taste-related parameters. Combined treatments with hot air and UV-C illumination were applied to minimally processed broccoli (*Brassica oleracea* L.) florets to investigate their effects on several quality and senescence parameters (Lemoine *et al*. 2008). In general, the results suggest that the effect of heat was more important than that of UV-C in extending the postharvest life of broccoli florets. Treatment at 48°C combined with a UV-C dose of 8 kJ/m^2 yielded caused the highest retention of green colour and the best maintenance of organoleptic quality.

Electron beam irradiation did not affect the overall sensory quality of mangoes at doses up to 1.5 kGy. Only fruits irradiated at 3.1 kGy were unacceptable by the panelists. Irradiation at 3.1 kGy enhanced the fruit's aroma characteristics (Moreno *et al*. 2007a). E-beam irradiation of blueberries up to 1.6kGy was found to be a feasible decontamination treatment that maintains the overall fruit quality attributes (Moreno *et al*. 2007b).

The efficacy of ethanol maintaining the overall quality of two table grape cultivars - 'Superior' and 'Thompson Seedless' - was tested (Lurie *et al*. 2007). The taste of the berries was not impaired by any of the ethanol applications. However, the taste of 'Thompson Seedless' grapes held for 8 weeks in modified atmosphere storage was affected by CO_2 levels above 7%.

The effect of aqueous chlorine dioxide (ClO_2) treatment on grape quality was examined during storage (Kim *et al*. 2008). Sensory evaluation showed that the treated grapes had better sensory scores than the controls, and therefore, ClO_2 treatment could be useful in improving the quality of grapes during storage.

Fruits of winter guava (*Psidium guajava*) were harvested at horticultural maturity and were exposed to ethylene gas at 100 µL/L for 24 h, or to aqueous solutions of ethephon at concentrations of 500, 750 or 1000 µL/L (Mahajan *et al*. 2008). Treatment with ethylene gas or 1000 µL/L ethephon solution resulted in pleasanter flavour, more desirable firmness and more acceptable sensory quality than the other treatments. The control fruits showed very poor ripening and were hard in texture with poor quality attributes.

Application of brief anaerobic stress might be beneficial for postharvest fruit quality and might induce volatile production and thereby improve fruit aroma (Pesis 2005). Shi *et al* (2005) subjected 'Murcott' mandarins and 'Star Ruby' grapefruit to anaerobic stresses by exposing them to N_2 atmospheres. They found that mandarins held under N_2 exhibited higher and earlier increases in the accumulation of the off-flavour volatiles than grapefruit, and sensory evaluations indicated that the taste of mandarins deteriorated markedly following exposure to anaerobic conditions and was rated as unacceptable after 48 h under N_2, whereas the taste of grapefruit deteriorated only slightly and was rated acceptable even after 72 h of N_2 exposure (Shi *et al*. 2005). Fallik *et al.* (2005a) found that following 24 h of anoxia treatment, tomatoes that were held at 20°C for 12 days had organoleptic qualities similar to those of untreated fruit that were kept in cold storage followed by simulated marketing condition.

The rapid-ripening summer apple cultivar 'Anna' was treated with 1-MCP at harvest, and fruit quality was measured instrumentally at intervals during ripening at 20°C, and the instrumental rating were compared with the sensory ratings of a trained panel and the hedonic scores of untrained tasters (Pre-Aymard *et al*. 2005). The highest hedonic scores were obtained by apples treated with 1-MCP at 1 µL/L and ripened for 12 days at 20°C. Recently, Gal *et al.* (2008) reported that the overall aroma notes in commercially-treated 'Galia'-type melons as tested by a trained panel, were significantly higher than those of 1-MCP-treated fruit. However, 1-MCP-treated fruit were preferred by both trained and untrained panels, which disliked commercially-washed and waxed fruit. Methyl acetate, as well as methyl 2-methylbutanoate, which are associated with the 'fruity' aroma note, were significantly higher in 1-MCP-treated fruit. The grassy note due to hexanal remained relatively high in 1-MCP-treated fruit after storage, while it was not detected in commercially-treated fruit. Ethanol, ethyl acetate and ethyl hexanoate volatiles that are associated with "off-flavour" and over ripening were significantly higher in commercially-treated fruit.

Dips in hot (60°C) 0.5% calcium chloride solution increased bound Ca levels, maintained the firmness of fresh-cut melon (*Cucumis melo* var. *saccharinus* Naud) and resulted in better sensory quality than control treatments or CaCl treatment at 5°C (Aguayo *et al*. 2008). Calcium propionate treatment decreased metabolic activity but imparted a slight off-flavour to the cut melon, therefore, treatment at lower calcium propionate concentrations must be studied to avoid this off-flavour. No Ca dip treatment induced a salty or bitter taste.

CONCLUDING REMARKS

The postharvest quality of fruits and vegetables can be influenced by a wide variety of genetic factors, preharvest and harvest practices, and postharvest treatments, as well as handling, transportation and marketing practices, but it is generally accepted that quality is established in the field (Tijskens and van Kooten 2006; Hodges and Toivonen 2008).

Consumption of fresh fruits is increasing as consumers become more aware of their nutritional value and their role in disease prevention. Improving the sensory properties of fresh fruit or vegetables that reach the consumer would add value, increase consumption, and create new markets for these commodities (Song and Forney 2008). Therefore, sensory quality is emerging as one of the most important quality attributes of horticultural products, and one that needs to be optimized through breeding, preharvest, harvest and postharvest practices. While sensory quality is recognised as an important factor in consumer acceptance and repeat purchase, it is seldom included in economic analyses of the fresh or the fresh-cut product market because of the difficulties in measuring it and matching it to consumer expectations (Laureati *et al*. 2006).

A better understanding of aroma and flavour metabolism, and its genetic control, improved breeding methods, and increased knowledge of maturation mechanisms and of the effects of pre- and postharvest practices will enable the consumer to purchase a better and tastier fresh or fresh-cut fruits and vegetables. Therefore, molecular genetic manipulation of specific genes or groups of genes to enhance or modify aroma and flavour generation in fruits and vegetables promises to be a highly active area of future research. In addition, training people to participate in taste panels will lead to potential product descriptors and to indicators of future product acceptance, though not to accurate purchase predictors. Furthermore, new instrument technologies such as Near Infra red (NIR) measurements or similar means can improve the capacity to predict the sensory quality of freshly harvested produce (Francois *et al*. 2008).

Nevertheless, in dealing with new cultivars, further work will be required to understand and optimise the commercial handling of each commodity, including selection of harvest maturity and optimization of storage protocols.

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