Quality Changes in Fresh-cut Peach and Nectarine Slices as Affected by Cultivar, Storage Atmosphere and Chemical Treatments

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ABSTRACT

The shelf-life of slices from 13 cultivars of peaches and 8 cultivars of nectarines, varied (between 2 and 12 days at 0°C). Controlled atmospheres of 0.25 kPa O₂ and/or 10 kPa or 20 kPa CO₂ extended the shelf-life at 10°C of ‘O’Henry’ or ‘Elegant Lady’ peach slices by 1-2 days beyond the air control. Low (0.25 kPa) O₂ acted synergistically with CO₂ levels of 10 and 20 kPa to induce fermentative metabolism as indicated by ethanol and acetaldehyde production. A 2% (w/v) ascorbic acid + 1% (w/v) calcium lactate postcutting dip resulted in limited reduction of cut surface browning and tissue softening in ‘Carnival’ peach slices.

Key Words: controlled atmosphere, fresh cut, stone fruit, peaches, nectarines

INTRODUCTION

THE COMMERICAL SUCCESS OF FRESH-CUT PEACH AND NECTARINE SLICES has been limited due to their short shelf-life, because of cut surface browning and pit cavity breakdown. Gorny et al. (1998a) determined that 18–31N firmness was the optimal stage of ripeness for whole fruit to be processed into peach and nectarine slices. This stage balanced shelf-life based on visual quality and that based on sensory quality when slices were held at 0°C. Phenotypic differences among peach and nectarine cultivars are considerable and which cultivars are best suited for fresh-cut processing is unknown. We have determined (Gorny et al., 1998a) that factors such as fruit ripeness at cutting and storage temperature could significantly affect the shelf-life of peach and nectarine slices. We hypothesized that the post-cutting life of nectarine and peach slices was also dependent on cultivar and storage atmosphere. Genotypic differences in postharvest life of nectarine and peach cultivars are well documented and the relative storage quality ranking among genotypes remains consistent from season to season (Mitchell and Kader, 1989).

Whole peaches and nectarines are tolerant of low O₂ and elevated CO₂ atmospheres (Ke and Kader, 1992). Controlled atmospheres of O₂ and CO₂ combinations have been reported to reduce the incidence of internal breakdown and extend postharvest shelf-life of whole peaches (Anderson, 1982; Retamales et al., 1992, Lurie, 1993;). Low storage temperature and modified atmosphere packaging are extensively used to extend the shelf-life of many fresh-cut fruit and vegetable products because they reduce rates of respiration and cut surface browning. Fresh-cut products may respond differently to atmospheric modifications than the whole commodities from which they are derived. Fresh-cut lettuce product packages commonly have less than 1 kPa O₂ to effectively slow browning caused by polyphenol oxidase (PPO) and more than 10 kPa CO₂ to inhibit microbial growth (Gorny, 1997). Thus the O₂ and CO₂ concentrations that maybe beneficial for extending shelf-life of a fresh-cut product may be quite different from those recommended for intact fruits and vegetables. No results have been published on how atmospheric modification may affect the shelf-life of fresh-cut nectarine and peach slices.

Cut surface browning, excessive flesh softening and pit cavity breakdown are major causes of fresh-cut peach slice quality loss (Gorny et al., 1998a). Ascorbic acid has long been applied in combination with organic acids and calcium salts to retard enzymatic browning and maintain firmness of processed fruit products (Santerre et al., 1988; Pizzocaro et al., 1993). Cut surface browning and loss of firmness can be significantly reduced in fresh-cut ‘Bartlett’ pear slices by a postcutting aqueous dip of 2% (w/v) ascorbic acid + 1% (w/v) calcium lactate (Gorny et al., 1998b). There are no published data on the efficacy of such treatments on fresh-cut peach slices.

The objectives of our work were to investigate: (1) genotypic differences in shelf-life of fresh-cut peach and nectarine slices; (2) the effects of low O₂ and/or CO₂-enriched atmospheres on shelf-life of fresh-cut peach slices; and (3) the effects of a 2% (w/v) ascorbic acid + 1% (w/v) calcium lactate postcutting treatment on reducing softening and cut surface browning of fresh-cut peach slices.

MATERIALS & METHODS

Plant materials and ripening conditions

Peaches and nectarines (70–72 count per 11.5-kg box, mean fruit mass = 163g), harvested commercially as “California Well Mature” (based on minimum degree of yellowness of ground color), were obtained from commercial grower/shippers in Fresno, CA, and transported to the department of Pomology postharvest laboratory in Davis. The peach and nectarine cultivars and harvest dates were: Peach—‘Flavorcrest’ (20 June 96), ‘Elegant Lady’ (7 July 96), ‘Summer Lady’ (22 July 96), ‘O’Henry’ (25 July 96), ‘Snow King’ (25 July 96), ‘Ryan Sun’ (30 July 96), ‘Red Cal’ (2 August 96), ‘August Lady’ (12 August 96), ‘Snow Giant’ (13 August 96), ‘Cal Red’ (23 August 96), ‘Red Sun’ (23 August 96), ‘Tra Zee’ (23 August 96), ‘Carmival’ (24 September 96) and Nectarine— ‘Zee Grand’ (6 June 96), ‘Summer Grand’ (6 July 96), ‘Summer Diamond’ (19 July 96), ‘Summer Fire’ (27 July 96), ‘Arctic Queen’ (28 July 96), ‘Sparkling Red’ (7 August 96), ‘August Red’ (23 August 96), and ‘September Red’ (4 September 96). Fruit were ripened at 20°C and 90–95% relative humidity in air + 10 Pa CO₂ H₂O. Ripeness stage was based on assessing the whole fruit flesh firmness (penetration force) of 20 fruit in each lot, by measuring the force required for an 8 mm probe to penetrate the cheek of a whole peach or nectarine, with the skin removed, to a depth of 10 mm using a University of California firmness tester (Western Industrial Supply Co., San Francisco, CA). After ripening to 18-31N, fruit were cooled to (~0°C in 3–4h using a laboratory scale forced-air cooling unit and held overnight at 0°C until cut.

Fruit ripeness-evaluation, cutting and storage

After ripening and cooling, the firmness of each individual fruit was determined, to select fruit with flesh firmness 18–31N. Each fruit was cut into 8 slices (wedges) with a sharp stainless steel knife, and...
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Quality evaluations

At the start of each experiment, and after 2, 4, 6, and 8 days, peach and nectarine fruit slices were evaluated both instrumentally and visually. The visual quality in each replicate was determined based on the following visual (hedonic) scale: 9 = excellent, just sliced; 7 = very good; 5 = good, limit of marketability; 3 = fair, limit of usability; and 1 = poor, inedible. A color photograph of slices rated via this scale was used by 2 or 3 judges to score slices based on color, visible structural integrity and general visual appeal. A weighted average of individual fruit slice quality scores was used to determine the mean visual quality score for each replicate. CIE L* a* b* values were determined with a Minolta chromameter (Model CR-200, Minolta, Ramsey, NJ) calibrated to a white porcelain reference plate (L* = 97.95, a* = −0.39, b* = 2.00). L* color value (white to black) was used to determine cut surface browning intensity. Peach and nectarine slice firmness (penetration force) was determined by measuring the force required for a 3 mm probe to penetrate the cut surface (midpoint between pit cavity and skin) of the slice, held perpendicular to the probe, to a depth of 10 mm using a University of California firmness tester.

Ethanol and acetaldehyde analyses

Juice samples were obtained from fruit slices with a fruit juicer, immediately frozen in liquid N₂, and stored in air tight containers at −80°C until analysis. Samples were thawed and analyzed by gas chromatography to determine the amount of acetaldehyde and ethanol present in each sample using the method of Gil et al. (1998). Compounds were quantified by comparison to known standard retention times and peak areas. Concentrations were expressed as nM in juice.

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**Statistical analysis**

Data were treated for multiple comparisons by analysis of variance with least significant difference (LSD) between means determined at 5% level.

**RESULTS & DISCUSSION**

**Effects of cultivar on shelf-life**

Shelf-life varied between 2 and 12 days at 0°C among the 13 cultivars of peaches and 8 cultivars of nectarines tested (Fig. 1). Among the peach cultivars, ‘Cal Red’, ‘Red Cal’ and ‘Elegant Lady’ slices had the longest shelf-lives of 7.4, 7.2 and 6.7 days, respectively, while ‘Summer Lady’ and ‘Ryan Sun’ slices had the shortest shelf-life (<2 days). Shelf-life based on visual appearance was limited by loss of sheen and gloss at the cut surface (likely due to localized dehydration of the cut surface), and pit cavity breakdown. Among the nectarine cultivars, ‘Sparkling Red’, ‘Arctic Queen’ and ‘Zee Grand’ slices had the longest shelf-lives of 12, 8 and 8 days, respectively, and slices of most of nectarine cultivars had shelf-lives of 4–6 days at 0°C and 90–95% relative humidity. Slices from white-fleshed peaches and nectarines had a range of shelf-lives comparable to yellow-fleshed cultivars. White and yellow fleshed cultivars had similar levels of cut surface browning (data not shown).

**Effects of chemical treatments on shelf-life and quality**

The 2% (w/v) ascorbic acid + 1% (w/v) calcium lactate dip apparently reduced the rate of cut-surface browning in ‘Carnival’ peach slices during the first 6 days of storage at 0°C, but this reduction was significant only on day 4 (Fig. 2A). Initially this treatment reduced the rate of flesh softening. After 8 days at 0°C there was no difference in flesh firmness among treated and untreated controls (Fig. 2B). The efficacy of ascorbic acid and calcium lactate to reduce browning and firmness loss in fresh-cut ‘Carnival’ peaches was minimal. This treatment did not increase the shelf-life or reduce pit cavity breakdown. Use of such chemical treatments may impart off-flavors that could be objectionable to some consumers (Ashie et al., 1996).

**Effects of controlled atmospheres on shelf-life and quality**

Low O$_2$ (0.25 kPa) and/or elevated CO$_2$ (10 or 20 kPa) atmospheres extended the shelf-life of ‘O’Henry’ peach slices kept at 10°C by 1 to 2 days (Fig. 3) compared to air. All low O$_2$ and/or elevated CO$_2$ atmospheres reduced peach slice ethylene production and respiration rates (data not shown). However, since ripening processes had already been induced in these fruit slices, the atmospheres did not completely stop senescence and tissue breakdown. The low O$_2$ and/or elevated CO$_2$ atmospheres induced production of fermentative metabolites (i.e., ethanol and acetaldehyde) in ‘Elegant Lady’ peach slices in a dose responsive manner (Fig. 4). Low O$_2$ and elevated CO$_2$ acted synergistically to increase production of ethanol and acetaldehyde in slices at 10°C which could cause objectionable off-flavors and odors. Therefore, appropriate sensory analysis is needed when modified atmospheres are used to extend shelf-life, since some atmospheres such as 0.25 kPa O$_2$ + 20 kPa CO$_2$, may extend shelf-life based on visual quality but impart off-flavors. Atmospheres enriched in CO$_2$ (up to 10 kPa) with sufficient O$_2$ levels to reduce fermentative metabolite production may be beneficial in extending the shelf-life of fresh-cut slices of some peach and nectarine cultivars without imparting objectionable sensory quality.

**CONCLUSIONS**

Cultivar, storage atmosphere and postcutting dips of ascorbic acid and calcium lactate affected the shelf-life of fresh-cut peach and nectarine slices. Selection of appropriate cultivars and appropriate maturity at harvest, followed by ripening to 18–31 N flesh firmness, and proper storage temperature (0°C) and relative humidity (90–95%), were the most important factors that determine shelf-life of fresh-cut peach and nectarine slices. Postcutting dips of ascorbic acid...
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and calcium lactate or use of modified atmospheres may slightly prolong the shelf-life of peach and nectarine slices, but the overall advantages of such treatments would be marginal.

REFERENCES


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