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Postharvest Physiology and Quality Maintenance of Sliced Pear and Strawberry Fruits

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ABSTRACT

Sliced strawberries (cvs. 'Pajaro' and 'G-3') and partially ripe pears (cv. 'Bartlett') were dipped in various solutions (citric acid, ascorbic acid, and/or calcium chloride) and stored in air or in controlled atmospheres (CA) for 7 days at 2.5°C followed by one day at 20°C. Fruit slices respired at a higher rate than whole fruits at both temperatures. CA storage suppressed respiration and ethylene production rates of sliced fruits. Firmness of strawberry and pear slices was maintained by storage in air + 12% CO_2 and in a 0.5% O_2 atmosphere, respectively, or by dipping in 1% calcium chloride. These treatments also resulted in lighter colored pear slices than the air control treatment.

INTRODUCTION

SLICED FRUIT can be expected to behave differently from whole fruit during storage because of the response to wounding and damage to the skin. Possible manifestations of slicing fruit include increased ethylene production and respiration rates, accelerated senescene and enzymatic browning.

Many examples of wound-induced ethylene production in fruit and vegetable tissue have been reviewed by Abeles (1973), Lieberman (1979), Yang and Hoffman (1984) and Yang and Pratt (1978). The stimulation of ethylene production by stress typically occurs within a lag of 10-30 min and subsides later after reaching a peak within several hours (Yang and Pratt, 1978; Yang and Hoffman, 1984). However, MacLeod et al. (1976) found that impact-bruised tomatoes exhibited sustained increases in rates of ethylene and CO_2 production.

The respiration of fresh slices is, in most cases, 3 to 5 times that of the intact organ, while aging elicits another comparable increase (Laties, 1978). Palmer and McGlasson (1969) found that transverse slices of green banana fruit exhibited an initial burst of respiration which subsided within 2 hr and a broad peak of "induced" respiration at 15-20 hr.

Various postharvest dip treatments have been utilized to control or alleviate degradative changes and prolong the storage life of fruits and vegetables. Calcium dips were shown to delay ripening (Wills and Tirmazi, 1982; Poovaiah, 1986), retard flesh softening (Bangerth et al., 1972) and retain vitamin C content (Drake and Spayd, 1983). Morris et al. (1985) reported that calcium dips were more effective in firming sliced strawberries than in firming whole strawberries. Calcium treatments reduced browning (Drake and Spayd, 1983) and enzyme activity (Hopfinger et al., 1984). Other dip treatments which retard enzymatic browning include ascorbic acid (Bauernfeind and Pinkert, 1970) and citric acid (Anonymous, 1983).

Controlled atmospheres (CA) retarded senescence (Brecht, 1980; Kader, 1980) and delayed softening of fruit (Knee, 1980). Elevated CO_2 atmospheres slowed down the softening rate of strawberries (Harris and Harvey, 1973); this effect was often noticeable after transfer of the berries to air (Kader, 1986).

CA has also been evaluated as a means of minimizing enzymatic browning. Murr and Morris (1974) found that storage of mushrooms in 0% O_2 (tank nitrogen) reduced discoloration and o-diphenoloxidase activity for up to 7 days. Browning of shiitake mushrooms was avoided in O_2 concentrations of 2% or less (minamida et al., 1980). Increased CO_2 reduced browning or other discoloration of lettuce (Singh et al., 1972; Siriphanich and Kader, 1985) and snap beans (Buescher and Henderson, 1977).

Previous work with sliced fruits and vegetables indicated that several factors influenced quality. In studies with lettuce, low temperatures (0-2°C), storing dry, minimizing physical damage, use of a sharp blade in a slicing action and minimizing microbial load were effective factors in extending storage life (Bolin et la., 1977; Krahn, 1977). Modified atmospheres of 2-3% O_2 reduced browning and maintained texture and flavor at a high level, whereas chemical treatments, including sodium bisulfite and $CaCl_2$, were of little or no value in extending storage life (Krahn, 1977).

In a study of refrigerated apple slices, Ponting et al. (1972) reported that neither ascorbic acid alone nor calcium alone was effective in preventing discoloration, but the combination treatment was very effective.

In this study, factors affecting the postharvest life of slices of a climacteric fruit ('Bartlett' pear) and a non-climacteric fruit (strawberry) were examined to evaluate the potential use of stored sliced fruits for fresh market consumption. Controlled atmosphere storage and various dip treatments were tested for their effects on the physiological behavior and quality maintenance of sliced pears and strawberries.

MATERIALS & METHODS

Strawberries

Strawberry cultivars 'Pajaro' and 'G-3' were obtained on the day of harvest in Watsonville, CA. They were transported to Davis, CA, in an air-conditioned vehicle and stored at 0°C until preparation for experiments the following morning.

The berries were sorted to remove defective and damaged fruit. Sound fruits were sorted by color to remove berries with less than 2/3 red or riper than full red surface color and matched samples were used for each treatment. Three replicates of 20 berries each were used per treatment.

Slice preparation

The calyx was removed, and the berries were sliced longitudinally into quarters. All utensils were cleaned thoroughly before use. Slices were placed in the inner bowl of a Copco Salad Spinner (Item No. 2555-04), dipped in 4L distilled water for 15 sec (60 sec for experiments evaluating dip treatments), drained 30 sec and then spun to remove excess water.

Pears

'Bartlett' pears (size 120, average fruit weight = 150 g) were obtained from a packinghouse in Lake County, CA, on the day of harvest and transported to Davis, CA, in an air-conditioned vehicle. These pears were used for various tests after storage at −1°C for 2 to 12 wk.

Pears were sorted to eliminate damaged or defective fruit. They were then partially ripened to approximately 44.5N firmness by ex-

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posures to 10 ppm ethylene at 20°C for 48 hr. After ripening, pears were arranged by color from green to yellow, and matched samples were used for the treatments. Slices from five fruits were used per each of thre replicates per treatment.

Slice preparation. Pears were cut into 12 wedges with a Westmark Divisorex corer/slicer. The fruit slices were then washed and spun as described for strawberries.

Storage

After preparation, the fruit slices were stored at 2.5°C for 7 days in glass jars ventilated with humidified air followed by 1 day at 20°C in nonhumidified air.

Experimental treatments

For strawberries, atmospheric treatments of 12% CO_2, 2% O_2 and 2% O_2 + 12% CO_2 were compared to air. All CA-treated fruit were returned to air upon transfer to 20°C on day 7. Dip treatments of 1% ascorbic acid, 1% citric acid, 1% ascorbic acid + 1% citric acid, 0.5% $CaCl_2$, and 1.0% $CaCl_2$ were compared to distilled water.

CA treatments for pears consisted of 0.5, 1.0, or 2.0% O_2. All CA-treated fruit were returned to air upon transfer to 20°C on day 7. Dip treatments were the same as those used on strawberries. In addition, a combination of 0.5% O_2 and 1% $CaCl_2$ was evaluated.

All experimental samples were compared to two controls: (1) untreated sliced fruit, and (2) whole fruit stored under control conditions and sliced on the day of evaluation.

Gas mixing and analysis

Fruits were placed in glass jars under continuous flow of humidified air or gas mixtures at known flow rates. The composition of atmospheres was measured daily with a Carle gas chromatograph model 211 using a thermal conductivity detector for O_2 and CO_2 and a flame ionization detector for ethylene. CO_2 production rates were measured with an Infrared Gas Analyzer, (HORIBA-PIR-2000R) using 10 mL effluent.

Color

A Gardner Color Difference Meter, Model No. XL-23, was used to evaluate external and internal color. It was calibrated with a white plate (X = 84.1, Y = 81.7, Z = 92.9) and the L, a, b scale was used.

The internal color of pears was measured over a 2 cm diameter orifice with a glass plate. Two measurements of each slice or fruit were taken; color of each replicate represents the average of 20 measurements.

Firmness

Strawberries. Firmness of 100 g of strawberries was evaluated in the compression/shear cell of a Food Technology Corporation Texture Test System Model TP-4 utilizing a 1334-N force transducer, a 30-sec ram time, and a 30-sec ram stroke integration time. Integrated area was measured with the Model TI texture integrator and Model TR5 Texturecorder.

Pears. Pear slice firmness was measured with a U.C. Fruit Firmness Tester supplied with an 8 mm tip. Resistance to penetration of the flesh was evaluated on the slice's cut surface, immediately adjacent to the sliced edge of skin.

Calcium content

Frozen fruit samples were dehydrated and 500 mg of fruit powder were digested with 3 mL concentrated nitric acid for 1 hr at 110°C, and 6 ml of 30% hydrogen peroxide were added. After cooling to room temperature, volume was brought to 50 mL with water, samples were filtered and analyzed on a Techtron AA 120 Atomic Absorption Spectrophotometer. A Varian Techtron D 1-30 Digital indicator was used, samples were compared to standard curve and are expressed as mg/100g FW.

RESULTS & DISCUSSION

Strawberries

The respiration rate of slices was greater than that of whole fruit throughout the 8-day storage period (Fig. 1). On day 8 (after transfer to 20°C) there was no difference between treatments. C_2H_4 production was negligible at 2.5°C (data not shown); this is typical of a nonclimacteric fruit. After transfer to 20°C, the C_2H_4 production of both whole and sliced fruits increased dramatically. The ethylene production of sliced fruit was about four times greater than that of whole fruit (0.40 vs 0.12 $\mu L/kg \cdot hr$). The increase in C_2H_4 production and CO_2 production in sliced fruit as compared to whole fruit is typical of a wounding response (Abeles, 1973; Laties, 1978).

After 7 days at 2.5°C, CA-stored 'Pajaro' strawberry slices were about the same firmness as air-stored slices and air-stored whole fruit (Table 1). Both 12% CO_2 and 2% O_2 were effective in minimizing loss of firmness of 'G-3' strawberries. These treatments had comparable firmness measurements to whole, freshly sliced fruit. The effect of CA on softening rate appeared to be cultivar-dependent. After transfer to 20°C and air, the 12% CO_2-treated slices were firmer than all other treatments for both cultivars. Kader (1986) reported the effect of CA on firmness retention in strawberries is often noticeable after return to air.

Calcium chloride dips resulted in higher calcium content but there were no differences in fruit firmness initially (Table 2). After 7 days at 2.5°C both 0.5% and 1.0% $CaCl_2$ dips resulted in firmer fruit with higher Ca contents than either water-dipped slices or whole, freshly sliced fruit. Although the calcium con-

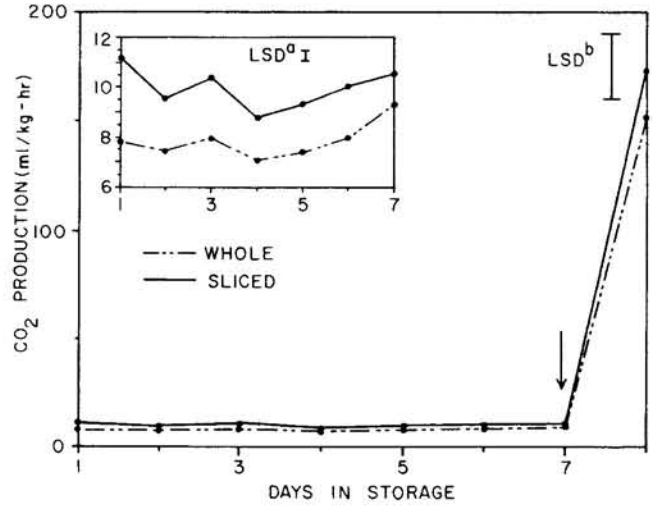

Fig. 1 – CO_2 production by strawberries stored in air at 2.5°C for 7 days (inset) and after transfer (indicated by arrow) to 20°C for 1 day. LSD[a] and LSD[b] are the least significant differences at 0.05 level for days 1 to 7 and day 8, respectively.

Table 1 – Effect of CA storage on firmness (relative shear force) of 'Pajaro' and 'G-3' strawberries after storage at 2.5°C for 7 days and after transfer to 20°C and air for 1 day

	Firmness			
	'Pajaro'		'G-3'	
Treatment	Day 7	Day 8	Day 7	Day 8
Air - sliced	69.6	58.6[b]	44.9[b]	44.5[b]
12% CO_2	63.6[ab]	70.0[a]	49.5[a]	49.8[a]
2% O_2	56.8[b]	60.3[b]	45.0[b]	38.8[c]
2% O_2 + 12% CO_2	66.9[a]	60.8[b]	48.3[a]	47.3[ab]
Air - whole, freshly sliced	68.1[a]	54.6[b]	49.2[a]	45.1[b]

[abc] Mean separation in columns for each evaluation time by Duncan's multiple range test, 0.05 level.

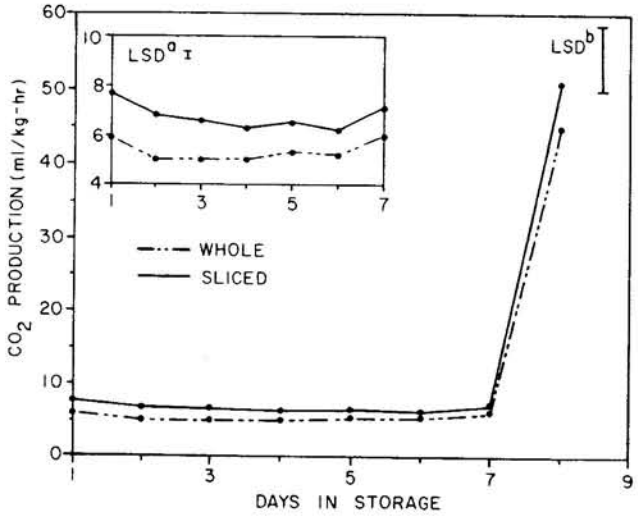

Fig. 2—CO_2 production by pears stored in air at 2.5°C for 7 days (inset) and after transfer (indicated by arrow) to 20°C for 1 day. LSD[a] and LSD[b] are the least significant differences at 0.05 level for days 1 to 7 and day 8, respectively.

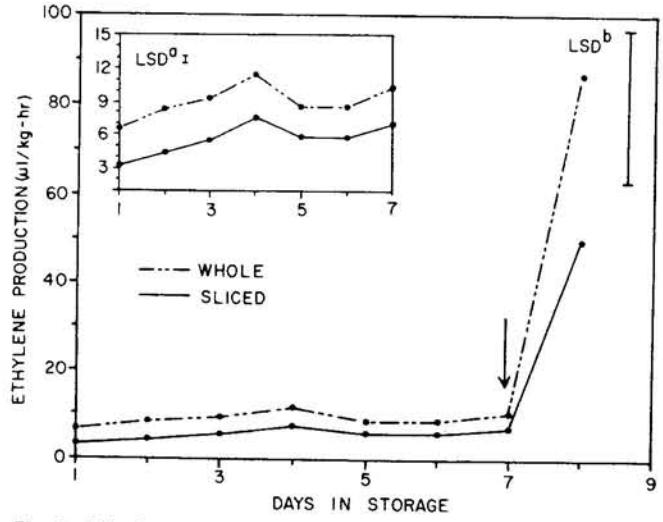

Fig. 3—Ethylene production by pears stored in air at 2.5°C for 7 days before transfer (indicated by arrow) to 20°C for 1 day. LSD[a] and LSD[b] are the least significant differences at 0.05 level for days 1 to 7 and day 8, respectively.

Table 2—Effect of $CaCl_2$ dips on firmness (relative shear force) of 'G-3' strawberries stored at 2.5°C for 7 days and at 20°C for 1 day

	Day 0		Day 7		Day 8	
Treatment	Firmness (N)	Ca (mg/100g)	Firmness (N)	Ca (mg/100g)	Firmness (N)	Ca (mg/100g)
Water	52.2	10.3[c]	47.1[b]	11.4[c]	47.3[b]	11.0[c]
0.5% $CaCl_2$	54.3	16.7[b]	56.3[a]	16.7[b]	53.4[a]	16.8[b]
1.0% $CaCl_2$	53.4	21.4[a]	57.0[a]	23.1[a]	56.7[a]	22.8[a]
No dip, freshly sliced	51.4	10.1[c]	48.9[b]	10.4[c]	53.7[a]	10.7[c]

[abc] Mean separation in columns for each evaluation time by Duncan's multiple range test, 0.05 level.

tent of 1% $CaCl_2$ dipped fruit was greater than that of the 0.5% $CaCl_2$ dipped fruit, their firmness values were not different. After transfer to 20°C, the $CaCl_2$-treated slices were as firm as whole, freshly sliced fruit, and they were firmer than water-dipped slices.

Pears

The sliced pears respired at a higher rate than whole pears throughout the 8 day storage period (Fig. 2). However, the differences were only significant during the 7 days at 2.5°C. The whole fruit consistently produced more C_2H_4 than the sliced fruit throughout the 8-day storage period (Fig. 3). The lack of a wounding response was probably due to the advanced stage of ripeness (postclimacteric stage) and subsequent saturation of the enzyme system responsible for C_2H_4 biosynthesis. Typically, wound-C_2H_4 is observed in pre-climacteric fruit (McGlasson and Pratt, 1964; McGlasson, 1969; Hoffman and Yang, 1982).

Air-stored sliced fruit respired at a higher rate than air-stored whole fruit during the 7 days at 2.5°C (Fig. 4). The low O_2-stored slices respired at a lower rate than the air-stored fruit, although there were no differences in respiration rate among the three low O_2 levels.

C_2H_4 production differed among treatments, with whole fruit producing the most C_2H_4, followed by air-stored slices, 2.0%, 1.0% and 0.5% O_2-stored slices, respectively (Fig. 5). O_2 is required for C_2H_4 production (Adams and Yang, 1979); therefore, one would expect lower O_2 levels to result in lower C_2H_4 production. After transfer to 30°C and air, the whole fruit had a higher level of C_2H_4 production. There were no significant differences among the three O_2 levels.

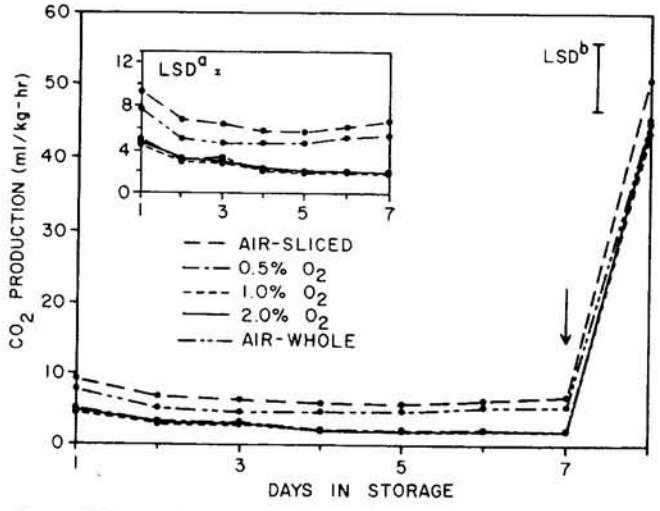

Fig. 4—CO_2 production by pears stored under various O_2 levels at 2.5°C for 7 days (inset) and after transfer (indicated by arrow) to 20°C and air for 1 day. LSD[a] and LSD[b] are the least significant differences at 0.05 level for days 1 to 7 and day 8, respectively.

After 8 days, slices stored under 0.5% O_2 were lighter in color than slices stored under air, with "L" values of 68.1 and 65.4, respectively. Also, the 0.5% O_2-stored slices were significantly firmer (34.7N) than the air-stored slices (25.4N) or whole freshly sliced fruit (28.9N) after 7 days at 2.5°C. CA storage has been shown to slow the rate of softening (Knee, 1980).

Slices from the 1.0% $CaCl_2$ dip treatment were lighter in color than water-dipped slices after 7 days at 2.5°C with "L" values of 72.6 and 67.9, respectively. $CaCl_2$ dip treatments were reported to reduce browning in apples (Drake and Spayd, 1983; Hopfinger et al., 1984). Citric acid and ascorbic acid dip treatments did not appear to be effective in minimizing browning (data not shown).

The 1.0% $CaCl_2$ treatment had an immediate firming affect on the slices since they were significantly firmer than water-dipped slices and whole, freshly sliced fruit (Table 3). The observed trend was consistent on day 7 and day 8.

The 1.0% $CaCl_2$ dip and the 0.5% O_2 treatments were found

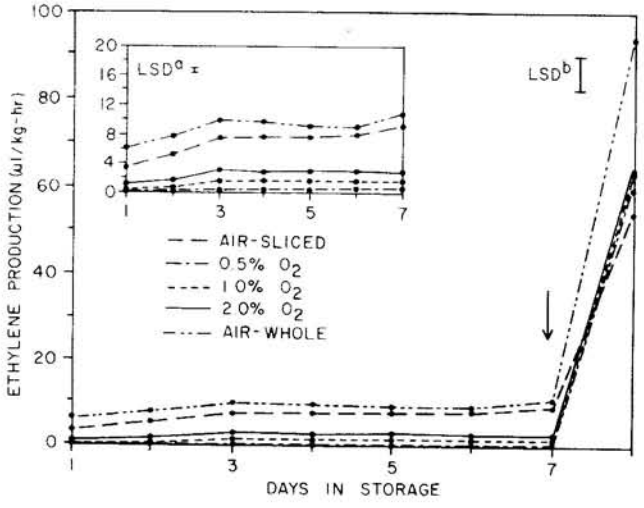

Fig. 5—Ethylene production by pears stored under various O_2 levels at 2.5°C for 7 days (inset) and after transfer (indicated by arrow) to 20°C and air for 1 day. LSD^a and LSD^b are the least significant differences at 0.05 level for days 1 to 7 and day 8, respectively.

Table 3—Effect of $CaCl_2$ dips on firmness (penetration force) of 'Bartlett' pears stored at 2.5°C for 7 days and at 20°C for 1 day

	Day 0		Day 7		Day 8	
Treatment	Firmness (N)	Ca (mg/100g)	Firmness (N)	Ca (mg/100g)	Firmness (N)	Ca (mg/100g)
Water	45.4[b]	7.8[b]	20.0[c]	7.3[b]	15.1[c]	6.8[b]
1.0% $CaCl_2$	49.4[a]	20.6[a]	35.1[a]	15.8[a]	28.0[a]	18.9[a]
No dip, freshly sliced	45.4[b]	7.3[b]	27.1[b]	6.8[b]	20.9[b]	6.1[b]

[abc] Mean separation in columns for each evaluation time by Duncan's multiple range test, 0.05 level.

Table 4—Effect of $CaCl_2$ and/or low O_2 on firmness (penetration force) of 'Bartlett' pear slices stored at 2.5°C for 7 days and at 20°C for 1 day

	Firmness (N)	
Treatment	Day 7	Day 8
Water + air	39.1[b]	29.8[c]
1% $CaCl_2$ + air	53.8[a]	39.6[b]
Water + 0.5% O_2	40.5[b]	38.3[b]
1% $CaCl_2$ + 0.5% O_2	59.2[a]	46.3[a]
Whole fruit, freshly sliced	34.7[b]	26.2[c]

[abc] Mean separation in columns for each evaluation time by Duncan's multiple range test, 0.05 level.

to be effective in maintaining firmness and a lighter color of slices. Therefore a combination of these two treatments was evaluated to determine whether they would have a synergistic effect. After 7 days at 2.5°C both $CaCl_2$ treatments resulted in firmer slices, although there was no difference between $CaCl_2$ + air or $CaCl_2$ + 0.5% O_2 (Table 4). On day 8 the combination of 1.0% $CaCl_2$ + 0.5% O_2 resulted in the firmest slices, followed by each of these treatments individually.

CONCLUSIONS

THE MAJOR CONSEQUENCES of slicing strawberries were an increase in CO_2 and C_2H_4 production and a loss of firmness. Storage in 12% CO_2 and $CaCl_2$ dips were effective in maintaining firmness of stored slices.

Slicing pears caused an increase in CO_2 production, but not in C_2H_4 production relative to intact fruit. Symptoms of deterioration due to slicing included browning and a loss of firmness. Storage in 0.5% O_2 was effective in reducing CO_2 and C_2H_4 production and in minimizing browning and softening. A 1.0% $CaCl_2$ dip was effective in reducing browning and loss of firmness. A combination of 0.5% O_2 and 1.0% $CaCl_2$ resulted in greater maintenance of firmness than either treatment alone after return to air.

Citric acid and/or ascorbic acid dips were not effective in controlling browning. Although these acids are recommended to control browning, their beneficial effects may be short-term.

REFERENCES

Abeles, F. B. 1973. "Ethylene in Plant Biology." Academic Press, New York.

Adams, D. O. and Yang, S. F. 1979. Ethylene biosynthesis: Identification of 1-aminocyclopropane-1-carboxylic acid as intermediate in the conversion of methionine to ethylene. Proc. Nat. Acad. Sci. 76: 170.

Anonymous. 1983. "Prevention of Browning in Fresh, Prepared Vegetables." Miles Laboratories, Inc., BioTech Division, Elkhart, IN.

Bangerth, F., Dilley, D. R., and Dewey, D. H. 1972. Effect of postharvest calcium treatments on internal breakdown and respiration of apple fruits. J. Am. Soc. Hort. Sci. 97: 679.

Bauernfeind, J. C. and Pinkert, D. M. 1970. Food Processing with added ascorbic acid. Adv. Food Res. 18: 219.

Bolin, H. R., Stafford, A. E., King Jr., A. D., and Huxsoll, C. C. 1977. Factors affecting the storage stability of shredded lettuce. J. Food Sci. 42: 1319.

Brecht, P. E. 1980. Use of controlled atmospheres to retard deterioration of produce. Food Technol. 34(3): 45.

Buescher, R. W. and Henderson, J. 1977. Reducing discoloration and quality deterioration in snap beans (*Phaseolus vulgaris*) by atmospheres enriched with CO_2. Acta Hort. 62: 55.

Drake, S. R. and Spayd, S. E. 1983. Influence of calcium treatment on 'Golden Delicious' apple quality. J. Food Sci. 48: 403.

Harris, C. M. and Harvey, J. M. 1973. Quality and decay of California strawberries stored in CO_2-enriched atmospheres. Plant Dis. Reporter 57: 44.

Hoffman, N. E. and Yang, S. F. 1982. Enhancement of wound-induced ethylene synthesis by ethylene in preclimacteric cantaloupe. Plant Physiol. 69: 317.

Hopfinger, J. A., Poovaiah, B. W., and Patterson, M. E. 1984. Calcium and magnesium interactions in browning of 'Golden Delicious' apples with bitter pit. Sci. Hort. 23: 345.

Kader, A. A. 1980. Prevention of ripening in fruits by use of controlled atmospheres. Food Technol. 34(3): 51.

Kader, A. A. 1986. Biochemical and physiological basis for effects of controlled and modified atmospheres on fruits and vegetables. Food Technol. 40(5): 99.

Knee, M. 1980. Physiological responses of apple fruits to oxygen concentrations. Ann. Appl. Biol. 96: 243.

Krahn, T. R. 1977. Improving the keeping quality of cut head lettuce. Acta Hort. 62: 79.

Laties, G. 1978. The development of control of respiratory pathways in slices of plant storage organs. In "Biochemistry of Wounded Plant Tissues," Kahl, G. (Ed.), p. 421. Walter de Gruyter and Co., Berlin.

Lieberman, M. 1979. Biosynthesis and action of ethylene. Ann. Rev. Plant Physiol. 30: 533.

MacLeod, R. F., Kader, A. A., and Morris L. L. 1976. Stimulation of ethylene and carbon dioxide production of mature-green tomatoes by impact bruising. HortSci. 11: 604.

McGlasson, W. B. 1969. Ethylene production by slices of green banana fruit and potato tuber tissue during the development of induced respiration. Aust. J. Biol. Sci. 22: 489.

McGlasson, W. B. and Pratt, H. K. 1964. Effects of wounding on respiration and ethylene production by cantaloupe fruit tissue. Plant Physiol. 56: 547.

Minamida, T., Nishikawa, T., and Ogata, K. 1980. The effects of CO_2 and O_2 on the shelf-life of shiitake (*Lentinus edodes*) after harvest. J. Jpn. Soc. Food Sci. Technol. 27: 505.

Morris, J. R., Sistrunk, W. A., Sims, C. A., and Main, G. L. 1985. Effect of cultivar, postharvest storage, preprocessing dip treatments and style of pack on the processing quality of strawberries. J. Am. Soc. Hort. Sci. 110: 172.

Murr, D. P. and Morris, L. L. 1974. Influence of 0_2 and CO_2 on o-diphenol oxidase activity in mushrooms. J. Am. Soc. Hort. Sci. 99: 155.

Palmer, J. R. and McGlasson, W. B. 1969. Respiration and ripening of banana fruit slices. Aust. J. Biol. Sci. 22: 87.

Ponting, J. D., Jackson, R., and Walters, G. 1972. Refrigerated apple slices: preservative effects of ascorbic acid, calcium and sulfites. J. Food Sci. 37: 434.

Poovaiah, B. W. 1986. Role of calcium in prolonging storage life of fruits and vegetables. Food Technol. 40(5): 86.

Singh, B., Yang, C. C., Salunkhe, D. K., and Rahman, A. R. 1972. Controlled atmosphere storage of lettuce. 1. Effects of quality and the respiration rate of lettuce heads. J. Food Sci. 37: 48.

Siriphanich, J. and Kader, A. A. 1985. Effects of CO_2 on total phenolics, phenylalanine ammonia lyase, and polyphenol oxidase in lettuce tissue. J. Am. Soc. Hort. Sci. 110: 249.

Wills, R. B. and Tirmazi, S. H. 1982. Effect of postharvest application of calcium on ripening rates of pears and bananas. J. Hort. Sci. 57: 431.

Yang, S. F. and Hoffman, N. E. 1984. Ethylene biosynthesis and its regulation in higher plants. Ann. Rev. Plant Physiol. 35: 155.

Yang, S. F. and Pratt, H. K. 1978. The physiology of ethylene in wounded plant tissues. In "Biochemistry of Wounded Plant Tissues," Kahl, G. (Ed.), p. 595. Walter de Gruyter and Co., Berlin.

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