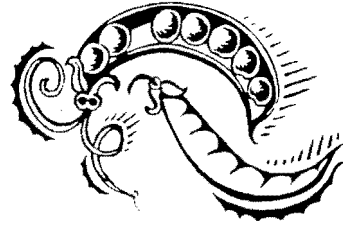


APPENDIX C



MODIFIED ATMOSPHERE PACKAGING: RECOMMENDATIONS and REQUIREMENTS

The source for the information provided in this Appendix is :
CA '97 Proceedings Volumes 1 to 5. Postharvest Horticulture Series No.
15 - 19. University of California, Davis. Specific references can be found
at the end of Chapter 5: Containers and Packaging Materials.

Recommendations and requirements for MAP of selected vegetables.

Source: Saltveit, 1997

Vegetable	Temperature ¹		Atmosphere ²		Application
	Optimum	Range	%O ₂	%CO ₂	
Artichokes	0	0-5	2-3	2-3	Moderate
Asparagus	2	1-5	Air	10-14	High
Beans, green snap	8	5-10	2-3	4-7	Slight
Beans, processing	8	5-10	8-10	20-30	Moderate
Broccoli	0	0-5	1-2	5-10	High
Cabbage	0	0-5	2-3	3-6	High
Cantaloupes	3	2-7	3-5	10-20	Moderate
Herbs ³	1	0-5	5-10	4-6	Moderate
Lettuce (crisphead)	0	0-5	1-3	0	Moderate

Vegetable	Temperature ¹		Atmosphere ²		Application
	Optimum	Range	%O ₂	%CO ₂	
Lettuce (crisphead) cut or shredded	0	0-5	1-5	-20	High
Lettuce (leaf)	0	0-5	1-3	0	Moderate
Mushrooms	0	0-5	3-21	5-15	Moderate
Peppers, chilies for processing	5	5-10	3-5	10-20	Moderate
Tomatoes (green)	12	12-20	3-5	2-3	Slight
ripe	10	10-15	3-5	3-5	Moderate

¹ Optimum and range of usual and/or recommended temperatures. A relative humidity of 90% to 95% is usually recommended.

² Specific CA recommendations depends on cultivar, temperature, and duration of storage.

³ Herbs: chervil, chives, coriander, dill, sorrel and watercress.

Recommendations for MAP of apples, pears and asian pears at -1 to 0 C.

Sources: Kupferman, 1997; Richardson and Kupferman, 1997.

Apple Variety:	O ₂ (%)	CO ₂ (%)	Temp.(°C)	Storage (months)
Braeburn	1.8	1.0	0.7	6-9
Fuji	1.4	1.0	0.3	7-11
Gala	1.7	1.6	1.3	2-9
Golden Delicious	1.6	2.3	0.5	7-11
Granny Smith	1.4	2.0	0.6	7-11
Idared	2.1	2.5	1.9	7-10
Jonagold	1.4	2.7	0.9	5-10
McIntosh	2.1	2.9	2.5	5-10
Red Delicious	1.6	1.8	0.0	6-11
Royal Gala	1.5	1.8	-0.2	5-8

	%O ₂	%CO ₂	Storage (months)	CA-disorders
Pear Variety :				
Abate Fetel	1	1	5-6	IB
Alejandrina	3	2	4-5	IB
Anjou, d'Anjou	1-2.5	0-0.5	7-8	IB,PBC,Cav
Bartlett (=William's Bon Chretien)	1-2	0-0.5	3-5	CF,PBC
Blanquilla (=Blanca de Aranjuez)	3	3	6-7	
Bosc. Kaiser	1-2.5	0.5-1.5	4-8	PBC, Cav
Buena Luisa (=Buona Luisa)	3	2	6	IB, CF
Clapp's Favorite	2	<0.7	3-4	IB, PBC
Comice	1.5-4	0.5-4	5-6	IB(overmature)
Conference	1-2.5	0.6-1.5	6-8	BH, IB, Cav
Coscia	1.5	2-3	6-7	CF
Flor d'Hivern(=Inverno)	3	3	4-5	IB
Forelle	1.5	0-1.5	6-7	
General Leclerc	2-3	2-3	3-5	
Grand Champion	3	2-2.5	4	
Hardy	2-3	3-5	4-6	
Josephine	1-2	1-2	8	
Krystalli	2	1-2	3-5	
Limonera, Llimonera	3	3	3-4	
Packham's Triumph	1.5-1.8	1.5-2.5	7-9	CB
Passe Crassane	3	4-5	5-8	IB
Rocha	2	2	8	
Spadona	1.5-2.5	1.5-3.5	8-9	IB
Asian pears:				
Chojuro	2	1-2	3-4	
Kosui	1-2	0-2	3-4	
Nijiseiki (=20 th Century)	0.5-3	0-1	5	
Tsu Li	1-2	0-3	3-5	IB
Ya Li	4-5	0-4	3-4	IB, Cav, CI?

'Ya Li' may show a type of chill injury at temperatures <5°C.

Optimum storage temperature is -1 to 0°C, unless otherwise indicated. (CA-disorder abbreviations are: IB=internal breakdown or browning; BH= brown heart; PBC= pithy brown core; CF= core flush; Cav= cavity, usually lens-shaped ; CI= chilling injury)

Recommendations and requirements for MAP of other fruits (CA² conditions). Source: Kader, 1997.

Commodity	Temperature Range ¹	% O ₂	%CO ₂	Commercial use (June, 1997)
Apricot	0-5	2-3	2-3	
Avocado	5-13	2-5	3-10	Used during marine transport
Banana	12-16	2-5	2-5	Used during marine transport
Blackberry	0-5	5-10	15-20	Used within pallet covers during transport
Blueberry	0-5	2-5	12-20	Limited use during transport
Cherimoya & Atemoya	8-15	3-5	5-10	
Cherry, sweet	0-5	3-10	10-15	Within pallet covers or marine containers during transport
Cranberry	2-5	1-2	0-5	
Durian	12-20	3-5	5-15	
Fig	0-5	5-10	15-20	Limited use during transport
Grape	0-5	2-5 or 5-10	1-3 10-15	Incompatible with SO ₂ Can be used instead of SO ₂ for decay control up to 4 weeks
Grapefruit	10-15	3-10	5-10	
Kiwifruit	0-5	1-2	3-5	Expanding use during transport/storage, with ethylene < 20 ppb
Lemon	10-15	5-10	0-10	
Lime	10-15	5-10	0-10	
Lychee (litchi)	5-12	3-5	3-5	
Mango	10-15	3-7	5-8	Increasing use during marine transport
Nectarine	0-5	1-2 or 4-6	3-5 15-17	Limited use during marine transport Used to reduce chilling injury (internal breakdown) of some cvs.
Olive	5-10	2-3	0-1	Limited use to extend processing season
Orange	5-10	5-10	0-5	
Papaya	10-15	2-5	5-8	
Peach,clingstone	0-5	1-2	3-5	Limited use to extend canning season
Peach, freestone	0-5	1-2 or 4-6	3-5 15-17	Limited use during marine transport Used to reduce incidence/severity of chilling injury of some cvs
Persimmon	0-5	3-5	5-8	Limited use of MA packaging
Pineapple	8-13	2-5	5-10	Waxing is used to create MA and reduce endogenous brown spot
Plum	0-5	1-2	0-5	Limited use for long-term storage of some cultivars
Pomegranate	5-10	3-5	5-10	
Rambutan	8-15	3-5	7-12	
Raspberry	0-5	5-10	15-20	Within pallet covers during transport
Strawberry	0-5	5-10	15-20	Within pallet covers during transport
Sweetsop (custard apple)	12-20	3-5	5-10	

¹Usual and/or recommended range; a relative humidity of 90-95% is recommended.

²Specific CA combination depends on cultivar, temperature, and duration of storage. These recommendations are for transport and/or storage beyond 2 weeks. Exposure to lower O₂ and/or higher CO₂ concentrations for shorter durations may be used for control of some physiological disorders, pathogen, and/or insects.

Recommendations and requirements for MAP of fresh-cut vegetables and fresh-cut fruits. Source: Gorny, 1997.

Fresh-Cut Product	Temperature (°C)	Atmosphere		Effectiveness
		%O ₂	% CO ₂	
Fresh-cut Vegetables:				
Beets (Red)				
Grated, Cubed, or Peeled	0-5	5	5	Moderate
Broccoli, Florets	0-5	2-3	6-7	Good
Cabbage, Shredded	0-5	5-7.5	15	Good
Cabbage (Chinese), Shredded	0-5	5	5	Moderate
Carrots				
Shredded, Sticks, or Sliced	0-5	2-5	15-20	Good
Leek, Sliced	0-5	5	5	Moderate
Lettuce (Butterhead), Chopped	0-5	1-3	5-10	Moderate
Lettuce (Green Leaf), Chopped	0-5	0.5-3	5-10	Good
Lettuce (Iceberg)				
Chopped or Shredded	0-5	0.5-3	10-15	Good
Lettuce (Red Leaf), Chopped	0-5	0.5-3	5-10	Good
Lettuce (Romaine), Chopped	0-5	0.5-3	5-10	Good
Mushrooms, Sliced	0-5	NOT RECOMMENDED		
Onion, Sliced or Diced	0-5	2-5	10-15	Good
Peppers, Diced	0-5	3	5-10	Moderate
Potato, Sliced or Whole-Peeled	0-5	1-3	6-9	Good
Rutabaga, Sliced	0-5	5	5	Moderate
Spinach, Cleaned	0-5	0.8-3	8-10	Moderate
Tomato, Sliced	0-5	3	3	Moderate
Zucchini, Sliced	5	0.25-1	-	Moderate
Fresh-cut Fruit:				
Apple, Sliced	0-5	<1	-	Moderate
Cantaloupe, Cubed	0-5	3-5	6-15	Good
Honeydew, Cubed	0-5	2	10	Good
Kiwifruit, Sliced	0-5	2-4	5-10	Good
Orange, Sliced	0-5	14-21	7-10	Moderate
Peach, Sliced	0	1-2	5-12	Poor
Pear, Sliced	0-5	0.5	<10	Poor
Persimmon, Sliced	0-5	2	12	Poor
Pomegranate, Arils	0-5	-	15-20	Good
Strawberry, Sliced	0-5	1-2	5-10	Good