

CA RECOMMENDATIONS FOR PEARS (INCLUDING ASIAN PEARS)

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The development of CA techniques applied to pear storage has had a large impact on four of the major varieties: Conference, Anjou, Packham's Triumph, and Passe Crassane. All of these are winter pear types, and have long inherent storability which can be enhanced by 20 to 40% with CA. As more pears are planted and shifts from processed fruit markets to fresh markets continue, more CA storage is expected. Even for pear processors, CA of Bartletts has extended the canning season, and maintained quality longer.

Some of the benefits of CA compared to regular refrigerated storage include better firmness retention, reduced scald, less chlorophyll breakdown, and better acidity retention. While there are substantial benefits from CA, factors increasing the susceptibility of fruits to carbon dioxide injury need to be understood, especially those relating to growing climate and mineral nutrition.

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Table 1. CA Conditions for Pear Varieties

<u>Variety</u>	<u>Temp.,C</u>	<u>%O₂</u>	<u>%CO₂</u>
Abate Fetel	-1	4	1
Anjou	-0.5	1-2	0-0.5
Bartlett (=Williams, or Bon Chretien)	-1	1-2	2-3
Bosc	-1	2-3	0.5-1.0
Clapp's Favorite	0	2	0
Comice	-0.5	2-4	2-4
Conference	0 -1	2 2	2 0
Forelle	-0.8	1.5	2
Hardy	-1	2-3	3-5
Inverno	0	3	5
Kaiser	-1	2-3	0.5-1
Kosui	0	1-2	?
Packham's Triumph	-0.5	2-3	1-2
Passe Crassane	-1	3-4	5-7
Nijiseiki	0	3	up to 1%
Spadona	-1	2.5	5
Tsu Li	0	1-2	up to 3
Ya Li	0	4-5	up to 5

COMMODITY: Pears

VARIETY: Abate Fetel

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1 to 0

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	4%	1%
Benefits:	firmness retention, acids retention, extended storage	
Potential for benefit:	good	
Injurious level:	3%	2%
Injury Symptoms:	pithy brown core	
Potential for injury:	?	?
Commercial use or potential:	only for small amounts in Italy	

REMARKS:

SELECTED REFERENCES: 2,11

COMMODITY: Pears

VARIETY: Anjou

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1 to 0

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	0.5 to 2%	0.5 to 2%
Benefits:	less scald, less rot, delayed senescence retained firmness	
Potential for benefit:	excellent	moderate
Injurious level:	0.3%	3% at 2-3% oxygen 0.5% if O ₂ is less than 1%
Injury Symptoms:	brown core	brown core, lens-shaped cavities near core
Potential for injury:	moderate	high if Oxygen is less than 2%
Commercial use or potential:	Extensively used: 2% O ₂ , 2% CO ₂ . Some commercial use of 0.5% O ₂ with CO ₂ less than 0.5%.	

REMARKS: Some beneficial effects of high (up to 12%) CO₂ for the first 2-4 weeks, followed by normal CA. However, maturity and seasonal effects can create adverse conditions limiting this initial high CO₂ treatment, as brown core risk is high.

SELECTED REFERENCES: 5,6,11,12,13,18,20,24

COMMODITY: Pears

VARIETY: Max Red Bartlett,
Bon Chretien

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	1 to 3%	1 to 3%
Benefits:	prolongs storage, delays ripening scald control(?), firmness retention	
Potential for benefit:	moderate	slight
Injurious level:	less than 1%	more than 3%
Injury Symptoms:	brown core	core flush, surface pitting
Potential for injury:	moderate	moderate to high
Commercial use or potential:	fair potential, but only used in small amounts	slight

REMARKS: these varieties are very temperature responsive, use of lowest possible temperature is imperative for longest storage, and rapid cooling at harvest is highly recommended.

SELECTED REFERENCES: 3,7,8,9,11,16,19

COMMODITY: Pears

VARIETY: Bosc

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	1 to 3%	0.5 to 1.5%
Benefits:	less decay, firmness retention delayed senescence	
Potential for benefit:	very good	poor
Injurious level:	less than 0.5%	more than 2%
Injury Symptoms:	brown core, lens shaped cavities near core area	
Potential for injury:	high	high
Commercial use or potential:	small, but increasing in the Pacific Northwest area of USA	

REMARKS: Weather seems to dramatically affect the CA response, in terms of disorder susceptibility, for this variety. Optimum maturity is more critical for this variety than for the other winter pear types.

SELECTED REFERENCES: 4,13,19,21

COMMODITY: Pears

VARIETY: Clapp's Favorite

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	2%	0%
Benefits:	retained firmness, extended storage life	
Potential for benefit:	good	limited
Injurious level:	?	?
Injury Symptoms:	brown core	
Potential for injury:	?	?
Commercial use or potential:	?	

REMARKS: Can be held for 155 days or more under the above conditions

SELECTED REFERENCES: Personal communication from Dr. Perry Lidster and Frank Forsyth, Kentville, Nova Scotia, Canada.

COMMODITY: Pears

VARIETY: Comice

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	2%	2-3%
Benefits:	retained firmness, prolonged storage	
Potential for benefit:	?	?
Injurious level:	?	3-5%
Injury Symptoms:	brown core	brown core
Potential for injury:	?	moderate
Commercial use or potential:	fair to good, but not commonly in use	

REMARKS:

SELECTED REFERENCES: 11,19

COMMODITY: Pears

VARIETY: Conference

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	2%	0 to 5%
Benefits:	retained firmness, prolonged storage, retained ripening capacity	
Potential for benefit:	good	moderate
Injurious level:	0.8% or less	?
Injury Symptoms:	brown heart, brown core	
Potential for injury:	?	?
Commercial use or potential:	extensively used wherever this variety is grown	

REMARKS:

SELECTED REFERENCES: 2,3,10,11,15,17,22,23, and personal communication from M. Herregods, Belgium.

COMMODITY: Pears

VARIETY: Forelle

OPTIMUM TEMPERATURE: -0.8

EXPECTED RANGE: -1 to +1

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	1.5%	2%
Benefits:	?	?
Potential for benefit:	?	?
Injurious level:	?	?
Injury Symptoms:	?	brown core
Potential for injury:	?	?
Commercial use or potential:	unknown	

REMARKS:

SELECTED REFERENCES: personal communication from L. Ginsburg, Stellenbosch, S. Africa.

COMMODITY: Pears

VARIETY: Hardy

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	2-3%	3-5%
Benefits:	firmness, color retention	
Potential for benefit:	good	fair
Injurious level:	?	5% or more
Injury Symptoms:	?	brown core
Potential for injury:	?	high above 5%
Commercial use or potential:	little used, but good potential	

REMARKS:

SELECTED REFERENCES: 11

COMMODITY: Pears

VARIETY: Inverno

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	3%	5%
Benefits:	longer storage, firmness, color retention	
Potential for benefit:	?	?
Injurious level:	?	?
Injury Symptoms:	?	?
Potential for injury:	?	?
Commercial use or potential:	small amount in Italy with other pears with similar requirements.	

REMARKS:

SELECTED REFERENCES: 11

COMMODITY: Pears

VARIETY: Kaiser

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	2-3%	0.5 to 1%
Benefits:	longer storage, firmness retention	
Potential for benefit:	good	
Injurious level:	?	?
Injury Symptoms:	?	?
Potential for injury:	?	?
Commercial use or potential:	unknown	

REMARKS:

SELECTED REFERENCES: 11

COMMODITY: Asian Pears

VARIETY: Kosui

OPTIMUM TEMPERATURE: 0

EXPECTED RANGE: -0.5 to +5

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	1-2%	?
Benefits:	delayed ripening	
Potential for benefit:	good	
Injurious level:	less than 1%	
Injury Symptoms:	surface pitting	
Potential for injury:	moderate	
Commercial use or potential:	none	

REMARKS:

SELECTED REFERENCES: preliminary data, personal communication from A. Kader, UC-Davis, California.

COMMODITY: Pears

VARIETY: Buona Luisa

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	3%	3%
Benefits:	longer storage, firmness retention	
Potential for benefit:	moderate	
Injurious level:	(?)	more than 4%
Injury Symptoms:	brown core	(?)
Potential for injury:	(?)	(?)
Commercial use or potential:	slight, a minor variety	

REMARKS:

SELECTED REFERENCES: 11

COMMODITY: Asian Pears

VARIETY: Nijiseiki or Twentieth Century

OPTIMUM TEMPERATURE: 0

EXPECTED RANGE: -1 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	3%	up to 1%
Benefits:	delayed ripening	
Potential for benefit:	good	slight to none
Injurious level:	1% after 4 mo.	more than 5%
Injury Symptoms:	surface pitting	flesh browning, gas pockets
Potential for injury:	moderate	high
Commercial use or potential:	none at this time	

REMARKS:

SELECTED REFERENCES: 25,26, and personal communications from A. Kader, UC-Davis, California, K. Kitagawa and K Kawada, Japan.

COMMODITY: Pears

VARIETY: Packham's Triumph

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1.5 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	2-3%	1-4%
Benefits:	color, firmness retention, long storage	
Potential for benefit:	excellent	
Injurious level:	0.5%	5% or more
Injury Symptoms:	flesh browning	core browning
Potential for injury:	moderate	
Commercial use or potential:	extensively used commercially, especially in Australia and S. Africa	

REMARKS:

SELECTED REFERENCES: 3,10,11

COMMODITY: Pears VARIETY: Passe Crassane
OPTIMUM TEMPERATURE: 0 EXPECTED RANGE: -1 to +1

REDUCED O₂ INCREASED CO₂

Beneficial level: 2-4% 5-8%
Benefits: firmness, color retention, long storage
Potential for benefit: very good, reduces internal browning of long storage in air
Injurious level: ca. 1% or less about 10%
Injury Symptoms: brown core brown core
Potential for injury: low low
Commercial use or potential: extensively used in Europe

REMARKS: Has quite high tolerance for CO₂, and can be held in CA at higher temperatures than most other pear varieties.

SELECTED REFERENCES: 2,3,11, and personal communication from P. Marcellin, France.

COMMODITY: Pears

VARIETY: Spadona

OPTIMUM TEMPERATURE: -1

EXPECTED RANGE: -1 to +1

	REDUCED O ₂	INCREASED CO ₂
Beneficial level:	2.5%	5%
Benefits:	firmness, storage	color retention, longer
Potential for benefit:	good	
Injurious level:	less than 1% (?)	more than 7%
Injury Symptoms:	brown core	core flush, peel browning
Potential for injury:	low	moderate
Commercial use or potential:	used extensively in Israel, about the only place where this variety is grown	

REMARKS:

SELECTED REFERENCES: personal communications from R. Ben-Arie and Arie Sive, Israel.

COMMODITY: Asian Pears

VARIETY: Tsu Li

OPTIMUM TEMPERATURE: 0

EXPECTED RANGE: -0.5 to +1

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	1-2%	?
Benefits:	delayed ripening	
Potential for benefit:	good	
Injurious level:	below 1%	?
Injury Symptoms:	flesh browning	
Potential for injury:	moderate	
Commercial use or potential:	none	

REMARKS:

SELECTED REFERENCES: Personal communication from A. Kader, UC-Davis, California and Qi Shou-Chun, Shanxi Fruit Institute, Taigu, Shanxi Province, P. Rep. of China.

COMMODITY: Asian Pears

VARIETY: Ya Li

OPTIMUM TEMPERATURE: 0

EXPECTED RANGE: -0.5 to +5

	REDUCED O ₂	INCREASED CO ₂
	-----	-----
Beneficial level:	4-5%	up to 5% (?)
Benefits:	delayed ripening	?
Potential for benefit:	moderate	?
Injurious level:	1%(1mo.), 2%(2mo.), 3%(4mo.)	?
Injury Symptoms:	flesh browning	?
Potential for injury:	high	?
Commercial use or potential:	none	

REMARKS:

SELECTED REFERENCES: Personal communications from A. Kader, UC-Davis, California, and Qi Shou-Chun, Peoples' Republic of China.

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