Evaluating the Roles of Ethylene and Storage Temperature on Fresh Fig Postharvest Changes

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Objective: Understand the roles of ethylene and temperature during storage of fig on changes during ripening and senescence.

Materials and Methods

The influence of exogenous ethylene exposure during cold storage on ripening fruit quality was assessed on three fig cultivars. 'Brown Turkey' and 'Kadota' harvested at two different maturity stages, green and commercial (50% mature), and 'Sierra' harvested at commercial stage, were stored at three different temperatures (32°F, 41°F and 68°F) and exposed to either air or air with the continuous addition of 10 ppm exogenous ethylene.

Firmness and fruit quality were evaluated immediately after different cold storage periods and during a warm display. Firmness was measured with a Fruit Texture Analyzer (FTA) (Güss, GS.14, Strand, South Africa) with a flat tip and expressed in pounds (lb). For the firmness measurements, 10 fruit were used per evaluation. Fruit quality measurements included percent purple color (for 'Kadota' only), percent of sound fruit (commercial fruit), percent of fruit with decay, percent of fruit with off color (not typical for the cultivar), percent of fruit with growth cracks, percent of fruit with splits, and percent of fruit with others blemishes. These quality parameters were measured in approximately 20 fruit per evaluation.

Conclusions

- Ethylene production (μl C_2H_4/kg-hr) decreased until the maturity stage M-2 (hard, larger than M-1 but smaller than M-3), had a peak in the maturity stage M-3 (larger than M-2, firm but not at commercial stage) and then continued decreasing.
- Respiration (ml CO_2/kg-hr) had an important reduction between the maturity stages M-1 (hard and small) and M-2 (hard, larger than M-1 but smaller than M-3), and then continued reducing slowly.
- Exogenous ethylene exposure did not affect any 'Brown Turkey', 'Kadota' and 'Sierra' fig quality parameter changes when stored at any temperature, except for 'Brown Turkey', purple skin color change on green maturity stage increased from 8.3% purple color to 100% when stored at 68°F. In these three cultivars, fig

firmness and internal maturity were related to storage temperature and maturity, but not to ethylene exposure (Table 1-3).

Table 1. Effect of application of 10 ppm continuous ethylene at different stages of maturity on fruit color, firmness and maturity changes under different storage temperatures for 'Brown Turkey' fig.

Temperature[Z]	Gas	Stage	Purple Color (%)	Firmness (lb)	Maturity[Y]
32°F	Air	Green	5.9	6.4	1.1
		(St Dev.)	(7.7)	(2.2)	(0.3)
		50% Mature	65.2	2.6	2.2
		(St Dev.)	(30.3)	(0.7)	(0.4)
	Ethylene	Green	9.3	6.4	1.1
		(St Dev.)	(8.1)	(1.1)	(0.3)
		50% Mature	69.0	1.5	2.2
		(St Dev.)	(28.7)	(0.6)	(0.4)
41°F	Air	Green	7.7	5.4	1.1
		(St Dev.)	(8.7)	(0.8)	(0.2)
		50% Mature	89.5	1.6	2.3
		(St Dev.)	(11.1)	(0.2)	(0.6)
	Ethylene	Green	6.8	4.8	1.1
		(St Dev.)	(7.3)	(1.0)	(0.2)
		50% Mature	87.8	2.8	2.1
		(St Dev.)	(10.9)	(1.8)	(0.8)
68°F	Air	Green	8.3	2.1	1.2
		(St Dev.)	(9.6)	(0.1)	(0.4)
		50% Mature	94.8	Decay	Decay
		(St Dev.)	(6.8)	--	--
	Ethylene	Green	100.0	2.1	1.3
		(St Dev.)	(0.0)	(0.6)	(0.4)
		50% Mature	98.8	Decay	Decay
		(St Dev.)	(3.9)	--	--

[Z] Fruit quality changes after 7 days.
[Y] Where 1=Low maturity, 2=Medium maturity and 3=High maturity.

Table 2. Effect of application of 10 ppm continuous ethylene at different stages of maturity on fruit firmness and maturity changes under different storage temperatures for 'Kadota' fig.

Temperature[Z]	Gas	Stage	Firmness (lb)	Maturity[Y]
32°F	Air	Green	3.7	1.9
		(St Dev.)	(1.1)	(0.6)
		50% Mature	3.3	2.0
		(St Dev.)	(1.3)	(1.0)
	Ethylene	Green	3.4	1.8
		(St Dev.)	(1.7)	(0.4)
		50% Mature	2.6	2.1
		(St Dev.)	(0.3)	(0.3)
41°F	Air	Green	3.0	1.6
		(St Dev.)	(0.9)	(0.5)
		50% Mature	1.9	2.1
		(St Dev.)	(0.4)	(0.3)
	Ethylene	Green	3.4	1.7
		(St Dev.)	(0.7)	(0.5)
		50% Mature	1.6	2.4
		(St Dev.)	(0.3)	(0.5)
68°F	Air	Green	1.4	3.0
		(St Dev.)	(0.6)	(0.2)
		50% Mature	1.1	3.0
		(St Dev.)	(0.3)	(0.0)
	Ethylene	Green	1.2	3.0
		(St Dev.)	(0.6)	(0.0)
		50% Mature	1.1	2.8
		(St Dev.)	(0.2)	(0.4)

[Z] Fruit quality changes after 13 days.
[Y] Where 1=Low maturity, 2=Medium maturity and 3=High maturity.

Table 3. Effect of application of 10 ppm continuous ethylene on fruit firmness and maturity changes under different storage temperatures for commercially harvested 'Sierra' fig.

Time	Temperature	Gas	Firmness (lb)	Maturity[Y]
6 days storage	68°F	Air	2.54	--
		(St Dev.)	(1.47)	--
		Ethylene	2.38	--
		(St Dev.)	(2.47)	--
11 days storage	32°F	Air	1.69	2.40
		(St Dev.)	(0.61)	(0.89)
		Ethylene	2.95	1.80
		(St Dev.)	(2.60)	(0.84)
	41°F	Air	1.82	2.20
		(St Dev.)	(1.10)	(0.84)
		Ethylene	2.27	2.00
		(St Dev.)	(1.01)	(1.00)

[Y] Where 1=Low maturity, 2=Medium maturity and 3=High maturity.

Table 4. Effect of application of 10 ppm continuous ethylene on quality changes under different storage temperatures for ‘Sierra’ fig after storage.

Storage (Days)	Temperature	Gas	Sound (%)	Decay (%)	Off Color (%)	Growth Cracks (%)	Splits (%)	Blemishes (%)
11	32°F	Air	50.0	0.0	31.8	13.6	0.0	18.2
11		Ethylene	70.8	0.0	8.3	8.3	0.0	16.7
11	41°F	Air	16.7	33.3	75.0	4.2	0.0	12.5
11		Ethylene	8.3	16.7	87.5	0.0	0.0	4.2
6	68°F	Air	33.3	62.5	33.3	0.0	0.0	0.0
6		Ethylene	20.8	70.8	62.5	0.0	0.0	0.0

Table 5. Effect of application of 10 ppm continuous ethylene on quality changes under different temperatures for ‘Sierra’ fig after storage +1 day at 68°F.

Storage (Days)	Temperature	Gas	Sound (%)	Decay (%)	Off Color (%)
11	32°F	Air	17.6	64.7	64.7
11		Ethylene	26.3	26.3	47.4
11	41°F	Air	10.5	52.6	89.5
11		Ethylene	5.3	36.8	94.7
6	68°F	Air	33.3	58.3	45.8
6		Ethylene	12.5	87.5	70.8

Table 6. Effect of application of 10 ppm continuous ethylene on quality changes under different temperatures for ‘Sierra’ fig after storage +2 days at 68°F.

Storage (Days)	Temperature	Gas	Sound (%)	Decay (%)	Off Color (%)
11	32°F	Air	8.3	66.7	83.3
11		Ethylene	7.1	57.1	92.9
11	41°F	Air	7.1	78.6	85.7
11		Ethylene	0.0	85.7	100.0
6	68°F	Air	4.2	79.2	70.8
6		Ethylene	4.2	91.7	87.5