

Effect of Controlled Atmosphere Storage on the Quality of Three Fresh Fig Cultivars

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Executive Summary

- Decay incidence was reduced and delayed by the CA treatment in the three tested cultivars.
- In ‘Kadota’, a yellow skinned cultivar, CA reduced the “off color” incidence, thus, increasing the percentage of sound fruit.

Objective

- Study the effects of controlled atmosphere (CA) storage on the market life of fresh fig cultivars.

Materials and Methods

Three fig cultivars, ‘Brown Turkey’, ‘Kadota’, and ‘Mission’, were stored under two different atmospheric conditions at 32°F: air (21% O₂ + 0.03% CO₂) and controlled atmosphere (CA) 6% O₂ + 17% CO₂ for storage times of 31, 31, and 19 days respectively. Flow rates and gas mixtures were established using a mixing board with micro-metering valves. Supply and exhaust gas O₂ and CO₂ composition was monitored using an Ametek paramagnetic oxygen analyzer (S-3A/II) and a Horiba infrared gas analyzer (VIA-510 for CO₂).

Fruit quality was evaluated immediately after each storage time and after 1, 2, and 3 days of display at 68°F simulating shelf life. The number of fruit evaluated per cultivar/treatment/storage time at 32°F is shown in Table 1.

Fruit quality evaluation included percent sound fruit (commercial fruit), percent fruit with decay, percent fruit with off color (not typical for the cultivar), percent fruit with growth cracks, percent fruit with splits and percent fruit with other blemishes. 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 storage and shelf life evaluations 25, 20, and 15 fruit per treatment were measured on ‘Brown Turkey’, ‘Kadota’ and ‘Mission’, respectively.

Results and Discussion

In this first year study, for all three cultivars, the percent decay was significantly higher on the air treated fruit than the CA treated fruit immediately after storage at 32°F and during shelf life evaluation at 68°F for up to 3 days (Tables 2, 3, & 4). All air-stored fruit of all three cultivars were 100% decayed after 2 days shelf life at 68°F. 'Kadota' figs stored under CA at 32°F for 31 days and during 3 days shelf life at 68°F had significantly higher percentages of sound fruit than the fruit stored under air. 'Kadota' (yellow) figs stored under CA for 31 days at 32°F and during shelf life at 68°F had significantly lower percent off color fruit than fruit stored under air (Table 3). CA treatment did not have a significant effect on the percent sound fruit of 'Brown Turkey' or 'Mission' (dark) figs immediately after storage at 32°F or during shelf life (Tables 2 & 4).

For all three cultivars, 'Brown Turkey', 'Kadota', and 'Mission', there was no significant difference between air and controlled atmosphere (CA) treatment for the percent growth cracks, splits or blemishes. There was no significant difference between air and CA treatment on the firmness of 'Brown Turkey' or 'Kadota' figs after storage at 32°F and after one-day shelf life evaluation at 68°F. CA treated 'Mission' figs were significantly less firm than the air treated fruit after storage at 32°F and after one-day shelf life evaluation at 68°F.

Conclusions

- Decay incidence was reduced and delayed by the CA treatment in the three tested cultivars.
- In 'Kadota', a yellow skin cultivar, CA reduced the "off color" incidence thus, increasing the percentage of sound fruit.
- As a next step, commercial and practical application of CA-packaging in the fresh fig industry should be attempted.

Table 1. Number of fruit evaluated per cultivar/treatment/storage time at 32°F.

Cultivar	Treatment	Days Storage	Fruit Evaluated
			(No.)
Brown Turkey	Air	31	200
	CA	31	200
Kadota	Air	31	200
	CA	31	216
Mission	Air	19	162
	CA	19	156

Table 2. Effect of atmospheric composition (air or CA: 6% O₂ + 17% CO₂) after 31 days at 32°F on the quality of 'Brown Turkey' fig measured immediately after storage and during shelf life (68°F) evaluation.

Time/Treatment ^z	Firmness ^x (lb)	Sound (%)	Decay (%)	Off Color (%)	Growth Cracks (%)	Splits (%)	Blemishes (%)
After 31 days at 32°F							
Air	0.9	69.5 a	1.5	25.0	5.5	8.0	8.5
CA	0.9	50.0 b	5.0	36.5	7.5	7.5	15.5
P-value	0.5228	0.0088	0.3089	0.3444	0.2623	0.9013	0.0958
LSD 0.05%	NS	13.1	NS	NS	NS	NS	NS
31 days at 32°F+1 day at 68°F							
Air	0.8	20.6	48.0 a	41.1 a	--	--	--
CA	0.7	36.0	13.7 b	22.9 b	--	--	--
P-value	0.1193	0.2651	0.0029	0.0415	--	--	--
LSD 0.05%	NS	NS	18.7	17.4	--	--	--
31 days at 32°F+2 days at 68°F							
Air	--	0.0	100.0 a	93.3 a	--	--	--
CA	--	0.7	66.7 b	69.3 b	--	--	--
P-value	--	0.3466	0.0014	0.0119	--	--	--
LSD 0.05%	--	NS	16.1	17.1	--	--	--
31 days at 32°F+3 days at 68°F							
CA	--	0.0	100.0	100.0	--	--	--

^z Air= 21% O₂+ 0.03% CO₂, CA= 6% O₂+ 17% CO₂

^x 'Brown Turkey' firmness at harvest= 1.8 lb

Table 3. Effect of atmospheric composition (air or CA: 6% O₂ + 17% CO₂) after 31 days at 32°F on the quality of 'Kadota' fig measured immediately after storage and during shelf life (68°F) evaluation.

Time/Treatment ^z	Firmness ^x (lb)	Sound (%)	Decay (%)	Off Color (%)	Growth Cracks (%)	Splits (%)	Blemishes (%)
After 31 days at 32°F							
Air	1.7	24.2 b	2.3	45.7 a	4.1	41.4	11.4
CA	1.8	68.5 a	0.0	3.7 b	5.1	25.9	6.9
P-value	0.9036	0.0039	0.1467	0.0102	0.6613	0.0823	0.2008
LSD 0.05%	NS	23.8	NS	27.9	NS	NS	NS
31 days at 32°F+1 day at 68°F							
Air	1.9	3.8 b	72.7 a	83.7 a	--	--	--
CA	2.0	62.8 a	0.0 b	14.3 b	--	--	--
P-value	0.7519	0.0003	<0.0001	<0.0001	--	--	--
LSD 0.05%	NS	19.6	7.4	17.8	--	--	--
31 days at 32°F+2 days at 68°F							
Air	--	0.0 b	100.0 a	100.0 a	--	--	--
CA	--	21.6 a	5.7 b	43.2 b	--	--	--
P-value	--	0.0065	<0.0001	<0.0001	--	--	--
LSD 0.05%	--	12.9	5.3	14.4	--	--	--
31 days at 32°F+3 days at 68°F							
CA	--	4.0	86.4	79.0	--	--	--

^z Air= 21% O₂+ 0.03% CO₂, CA= 6% O₂+ 17% CO₂

^x 'Kadota' firmness at harvest= 4 lb

Table 4. Effect of atmospheric composition (air or CA: 6% O₂ + 17% CO₂) after 19 days at 32°F on the quality of ‘Mission’ fig measured immediately after storage and during shelf life (68°F) evaluation.

Time/Treatment ^z	Firmness ^x (lb)	Sound (%)	Decay (%)	Off Color (%)	Growth Cracks (%)	Splits (%)	Blemishes (%)
After 19 days at 32°F							
Air	2.5 a	46.3	15.4 a	1.9	25.9	0.0	13.0
CA	1.1 b	55.1	0.6 b	5.1	28.9	0.0	11.5
P-value	0.0273	0.4654	0.0004	0.2626	0.7559		0.6964
LSD 0.05%	1.2	NS	3.9	NS	NS	NS	NS
19 days at 32°F+1 day at 68°F							
Air	1.8 a	38.1	30.6	8.2	--	--	--
CA	1.3 b	54.6	13.5	5.7	--	--	--
P-value	0.0053	0.2232	0.1232	0.4798	--	--	--
LSD 0.05%	0.3	NS	NS	NS	--	--	--
19 days at 32°F+2 days at 68°F							
Air	--	5.3	94.7	31.1	--	--	--
CA	--	9.5	75.4	21.4	--	--	--
P-value	--	0.6921	0.2052	0.5422	--	--	--
LSD 0.05%	--	NS	NS	NS	--	--	--
19 days at 32°F+3 days at 68°F							
Air	--	2.3	97.0	61.4	--	--	--
CA	--	3.2	96.8	29.4	--	--	--
P-value	--	0.7275	0.9502	0.0945	--	--	--
LSD 0.05%	--	NS	NS	NS	--	--	--

^z Air= 21% O₂+ 0.03% CO₂, CA= 6% O₂+ 17% CO₂

^x ‘Mission’ firmness at harvest= 2.4 lb