Developing the California fresh fig industry

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Abstract

The fig (*Ficus carica*), one of the first cultivated trees in the world, is grown in most of the of the world's moderate climates. However, fresh figs are highly sensitive to physical damage, and susceptible to postharvest infections which cause high losses during marketing. Preharvest orchard and postharvest conditions are important for improving fruit quality and postharvest life. Reducing postharvest losses and developing global fresh fig marketing is a challenge for plant breeders, physiologists and postharvest scientists. Our program focuses on increasing consumer consumption by identifying cultivars with high quality and suitable postharvest attributes, developing postharvest handling technologies, and improving marketing. Our postharvest evaluations of consumer acceptance and the firmness and decay susceptibility of promising fresh figs in the National Clonal Germplasm Repository (NCGR) suggested a breeding program for developing firm fleshed cultivars with high consumer acceptance.

Keywords: postharvest evaluations, consumer acceptance, losses, firmness, postharvest technologies, breeding programs

INTRODUCTION

Figs are nutritious, rich in fiber, potassium, calcium, and iron (Chessa, 1997), with levels higher than other fruits, such as bananas, grapes, oranges, strawberry, and apples (Chessa, 1997; Michailides, 2003). Figs are sodium-free, fat-free, and like other fruits, cholesterol-free. Figs are also an important source of vitamins, amino acids, phenolics, and antioxidants (Solomon et al., 2006). The fig is a syconium, a fleshy structure which encloses hundreds of fruits (Çelikel and Karaçalı, 1998; Piga et al., 1998; Stover et al., 2007). The (Chessa, 1997; Piga et al., 1998) syconium opening, the ostiole, has overlapping scales. Cultivars with a large ostiole (Doster et al., 2002) are susceptible to ostiole splitting (Michailides, 2003) and are more susceptible to decay. The high susceptibility of figs to decay, in combination with their fast ripening, which accelerates fruit softening (Çelikel and Karaçalı, 1998) makes fresh fig shelf life extremely short, lasting only 1-2 days (Morton, 2000). As a result, the majority of fresh fig consumption takes place near the centers of production (Piga et al., 1998).

Fig maturity at harvest affects fig soluble solids concentration (SSC), titratable acidity (TA), firmness, loss of firmness during storage, ethylene production, respiration rate, shelf life, ostiole diameter, shriveling, flavor and consumer acceptance (Crisosto et al., 2010). An 'in store' consumer evaluation of four California fresh fig cultivars at two maturity stages determined that the degree of liking (acceptance) was affected primarily by cultivar and maturity at harvest. With all four cultivars, figs harvested at tree ripe maturity had a significantly higher acceptance rating than figs harvested at commercial maturity. The average acceptance for the four cultivars averaged 86% for the tree ripened versus 55% acceptance for commercially ripened figs (Crisosto et al., 2010). This low acceptance level of commercially ripened figs combined with their high postharvest losses makes successful

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marketing difficult. New cultivars that can be harvested at advanced maturity stage, or at commercial maturity and tolerate postharvest handling, need to be identified. Unfortunately, the availability of high consumer quality cultivars that can be harvested at advanced maturity stage and remain firm during postharvest handling is limited. Thus, we searched for genotypes-cultivars with low decay susceptibility, predominant desired sensory characteristics such as sweetness, pleasant volatiles and texture that remained firm during postharvest handling (Kaynak et al., 1998; Crisosto et al., 2010; King et al., 2012; Haug et al., 2013).

As a large number of American consumers are still unaware of fresh figs. Educational promotion of selected genotypes with high consumer quality that remain firm during harvesting and marketing will expand fig markets.

MATERIALS AND METHODS

The National Clonal Germplasm Repository (NCGR) in Davis, California, has the largest fig cultivar collection in North America. We jointly evaluated ten fig cultivars/selections from this collection for quality and shelf life in 2005 and 2006. The average temperatures during the months of harvest were 22.3 and 21.7°C in 2005 and 2006, respectively.

The 152-4s, 'Brown Turkey', 'Kadota', 'Mission', 'Orphan', 'Panachee', UCR 276-14, UCR 291, 'White Texas Everbearing', and 'Zidi' cultivars were selected for evaluation. Fruits were harvested from 21-year-old trees spaced at 4.6×4 m. The fruits were harvested at two different maturity stages: commercial and tree ripe. Commercial maturity fig is defined as physiologically mature with the flesh giving slightly when touched. Tree ripe maturity was more mature and softer than commercial maturity, but not overripe. After harvest, fruit quality attributes were measured for each cultivar/selection and maturity stage. Simultaneously fruit samples were stored at 0°C for shelf life evaluation. Fruit quality measurements included firmness, fresh weight, ethylene production (evolved ethylene), respiration (CO_2 production), skin color, soluble solids concentration (SSC), and titratable acidity (TA). Fruit firmness was measured on 10 and 14 fruit in 2005 and 2006, respectively, using a Fruit Texture Analyzer (FTA) (Güss, GS.14, Strand, South Africa) adapted with a flat tip. Each fig was compressed on the cheek with a 2.5-cm flat tip at a speed of 5 mm s^{-1} to a depth of 4 mm to obtain the maximum force value in Newtons (N). Individual fresh weight in grams was measured on 6 and 18 representative fruit in 2005 and 2006, respectively, with a digital scale (model PM 4000, Mettler Instrument Corp., Hightstown, N.J.). For determination of evolved ethylene and respiration at 20°C, 6 and 3 fruits in 2005 and 2006, respectively, were individually weighed with a digital scale and put in 705 mL sealed plastic containers. Air samples from the containers were withdrawn after 1 h. The concentration of ethylene was determined with a gas chromatograph equipped with a flame ionization detector (Carle AGC-211, EG&G Chandler Engineering, Tulsa, Okla.), 8% NaCl on Alumina F-1 column, helium (40 psig, 30 mL min^{-1}) as carrier, and air and hydrogen (18 and 26 psig, respectively) as combustion gasses. Ethylene production rates were calculated and expressed as µL C_2H_4 kg^{-1} h^{-1}. The respiration rate was determined with an infrared CO_2 analyzer (model PIR-2000R; Horiba Instruments, Irvine, Calif.) and calculated and expressed as mL CO_2 kg^{-1} h^{-1}. Skin color was measured on 40 and 18 fruit in 2005 and 2006, respectively, using a Minolta colorimeter (model CR-200, Osaka, Japan). The data were expressed as luminosity [L, ranging from darkness (negative L) to lightness (positive L)], chroma (C, indicating intensity or saturation of the color), and hue (H, angle that indicates the pure spectrum color, i.e., which wavelength is most dominant). For SSC and TA, the flesh of six figs were pressed through cheesecloth with a hand press for a composite juice sample (Crisosto et al., 2010). Two and three composite juice samples were obtained in 2005 and 2006, respectively. The juice was measured for SSC with a temperature compensated handheld refractometer (model ATC-1, Atago Co., Tokyo, Japan) expressed as a percentage. Three grams of each composite juice sample were used for determination of TA with an automatic titrator (model 950, Orion, Boston, Mass.) and reported as a percentage of citric acid. Fig physical parameters included fig size (diameter and length), ostiole diameter, skin thickness, cavity diameter, and percentage of fruit with shriveling. Fruit diameter and length, as well as ostiole diameter, skin thickness, and cavity diameter were measured with a caliper (SPI 2000, dial caliper).

For shelf life evaluation, two and three replications in 2005 and 2006, respectively, of 18 fruit cultivar^{-1} and maturity stage were stored at 0°C for 7 days, and then held at 20°C. The fruit was evaluated for fruit quality immediately after cold storage, and after 2 and 3 days at 20°C (shelf life) in 2005, and after 1, 2, and 3 days at 20°C in 2006. Firmness was measured with the FTA, following the previously described methodology, immediately after cold storage and after 1 or 2 days at 20°C in 2005 and 2006, respectively. Fruit quality parameters were expressed as percentage of the total including the sound fruit (commercial fruit) and fruits with decay, off color (color not typical for the cultivar), growth cracks, splits, juice on the ostiole, and other blemishes. The percentage of fruit with growth cracks and splits was only measured for the first evaluation (after storage). In 2006, decay was divided into beginning signs of decay (without mycelium) and decay with mycelium. Percentage of fruit with juice in the ostiole was only evaluated in 2006.

RESULTS AND DISCUSSION

Fruit weight and size (diameter and length) were not affected by maturity stage. 'Zidi' and UCR 291 were consistently the heaviest cultivars both seasons. In 2005, but not 2006 'Brown Turkey' was also heavy. 'Black Mission' had the lowest weight (Tables 1 and 2). The cultivars with the largest diameters were 'Orphan' (48.0 mm), 'Zidi' (47.3 mm), 'Brown Turkey' (47.1 mm), UCR 291 (46.1 mm), and UCR 276-14 (45.0 mm), while 'Mission' was the was smallest (36.1 mm). 'Zidi' had the longest figs (62.7 mm), while the other cultivars were similar averaging 46 mm. Ethylene production and respiration rates (CO_2 production) were affected by maturity stage. Tree ripe figs had lower ethylene production and respiration rates than figs harvested at commercial maturity. This decrease in ethylene production and respiration rates from commercial maturity to tree ripe maturity may be due to the fact that both maturity stages are after the climacteric pick. The cultivars with the highest ethylene production were UCR 276-14 and 'Mission' in 2005, and 'Mission' and 'Brown Turkey' in 2006. The cultivars with the highest respiration rates were 'Panachee' in 2005, and 'Mission' and 'Brown Turkey' in 2006. The cultivars with the lowest ethylene production were 'Kadota', 'White Texas Everbearing', and 'Zidi' in 2005, and 152-4s and 'Zidi' in 2006. The cultivars with the lowest respiration rates were 'Zidi' and 'White Texas Everbearing'. Generally, ethylene production and respiration rates were higher in 2006 than in 2005 (Tables 1 and 2).

Skin color (L, C, H) was not affected by maturity stage or season. The green cultivars, 152-4s, 'Kadota', 'Orphan', 'Panachee', UCR 276-14, UCR 291, and 'White Texas Everbearing', had higher luminosity (L≈74) and chroma (C≈50.7) than the darker cultivars, 'Brown Turkey', 'Mission', and 'Zidi'. Luminosity of the dark cultivars averaged 36, with a chroma of 5.4 for 'Mission' and 'Zidi', and of 15.5 for 'Brown Turkey'. The hue value averaged 106.8° for the green cultivars, the normal range of the green-yellow colors, except for the cultivar 'Panachee' with a slightly lower hue of 96.3°, indicating yellow. 'Mission' and 'Zidi', the hue averaged 314°, in the purple range, and for 'Brown Turkey', hue value was 13.5°, which denotes more reddish colors (Tables 1 and 2). SSC and TA were also affected by maturity stage and season. Tree ripe figs had higher levels of SSC, averaging 22% higher, lower TA, around 30% lower, and higher SSC:TA ratios than commercial figs. Fruit from 2006 season had higher SSC than 2005 season fruit. TA was also affected by season, but was dependent on the cultivar. The TA levels of 'Kadota', 'White Texas Everbearing', and 'Zidi' were higher in 2005, while TA levels of 'Brown Turkey', 'Mission', 'Orphan', 'Panachee', and UCR 291 were higher in the 2006. In general, the cultivars with the highest SSC were 'White Texas Everbearing', 'Zidi', 'Panachee', 'Mission', and 'Kadota'. The cultivar with the lowest SSC was 'Orphan' (13.9%). Generally, the cultivar with the highest TA levels was 'Panachee', 0.64% and 0.97% in 2005 and 2006, respectively, followed by 'Zidi' and 152-4s in 2005, and followed by UCR 291 and 'Mission' in 2006. The cultivars with the lowest TA levels were 'Orphan' in 2005, and 'Kadota' and 'White Texas Everbearing' in 2006. Kadota' and 'White Texas Everbearing' had the highest SSC:TA ratio in 2006, while in 2005 season there were few differences among cultivars.

Initial fruit firmness was affected by maturity stage and season. Figs harvested at commercial maturity were twice as firm as those harvested when tree ripe. Firmness was around three times higher in the 2005 season than in the 2006 season. Figs harvested at commercial maturity lost more firmness during storage (cold storage and shelf life) than those harvested at tree ripe maturity. This is consistent with the positive relationship demonstrated between initial firmness and firmness lost during storage (R^2=0.87 and p-value=0.0001). Tree ripe figs remained softer than figs harvested at commercial maturity after a week of cold storage plus 1 and 2 days of shelf life in 2005 and 2006, respectively. Initial firmness was positively related to firmness during shelf life, R^2=0.84 and p-value=0.0001. In general, figs lost more firmness per day during shelf life than during cold storage.

Tree ripe figs had larger ostiole diameters than figs harvested at commercial maturity. Ostiole diameter was variable among fig cultivars. 'Zidi' and 'Brown Turkey' harvested when tree ripe had the largest ostiole diameters, while the'Mission' had the smallest. Fig skin thickness was not affected by maturity stage, except for 'Orphan' where tree ripe figs had thinner skin. UCR 291, 152-4s, and 'Kadota' had the thinnest skins. Fruit internal cavity diameter was variable among fig cultivars. The cultivars with the largest internal cavity diameters were 'Orphan' and 'Brown Turkey'. The percentage of fruit with shriveling was affected by maturity stage, with tree ripe fruit being the most affected. Most of the fig cultivars studied did not shrivel when harvested at commercial maturity, except for UCR 276-14 (5%), 'Zidi' (10%), and 'Orphan' (15%). On the other hand, all cultivars studied shriveled when harvested at tree ripe maturity.

Fig shelf life was affected by fruit maturity stage. Figs harvested at commercial maturity and stored for a week at 0°C had higher percentages of sound fruit immediately after cold storage and after 1, 2, and 3 days at 20°C (shelf life) than tree ripe fruit under the same conditions. In general, 50% of the fruit harvested at commercial maturity remained sound after 3 days of shelf life. However, less than 50% of the fruit harvested at tree ripe maturity was sound after the second day of shelf life in 2005. The percentage of sound fruit after storage and during shelf life was higher in the 2005 season than in 2006. For instance, in 2006 'Mission' cultivar had the highest percentage of sound fruit, while 'White Texas Everbearing' and UCR 291 had the lowest percentage of sound fruit after cold storage. In 2005, the percentages of sound fruit varied more. After 3 days of shelf life, 'White Texas Everbearing' and 'Orphan' had the lowest percentages of sound fruit. There was a positive relationship between fruit firmness, after harvest, after cold storage, and during shelf life, with the percentage of sound fruit during shelf life, R^2 values of 0.70-0.74 and p-values=0.0001. The percentage of sound fruit was not related to any other quality or physical parameter. Tree ripe fruit were more affected by decay than fruit harvested at commercial maturity, particularly during shelf life. In 2005, fruit had no decay immediately after cold storage, independent of maturity stage at harvest. The percentage of decayed fruit was higher in 2006 than in 2005. In 2005, 'Kadota', 'Mission', 'Orphan', 'Panachee', and 'Zidi' harvested at commercial maturity did not decay after 3 days in shelf life, while only 'Kadota' and 'Mission' did not decay when harvested at tree ripe maturity. The UCR 291 cultivar had the highest percentage of decayed fruit after 3 days of shelf life in 2005. In 2006, 'White Texas Everbearing' was the cultivar most affected by decay, while 'Orphan' was least affected. There was a significant negative relationship between fruit firmness after 1 and 2 days of shelf life in 2005 and 2006, respectively, and the percentage of decayed fruit the following day (R^2=0.71 and p-value=0.000).

Table 1. Initial fruit quality attributes measured on 10 fig cultivars/selections harvested at commercial and tree ripe maturity stages at the ARS National Clonal Germplasm Repository (NCGR), Davis, in 2005.

Cultivar	Maturity stage	Weight (g)	Ethylene (μL C_2H_4 kg^{-1} h^{-1})	Respiration (mL CO_2 kg^{-1} h^{-1})	Color			SSC (%)	TA (% citric acid)	SSC:TA
					L	C	°H			
152-4s	Commercial	35.0	1.65	41.20	75.9	47.2	110.7	13.6	0.57	23.7
	Std. Dev.	9.6	0.36	5.96	7.4	4.1	6.0	0.6	0.02	1.8
	Tree Ripe	40.5	3.87	28.57	76.9	47.8	105.3	19.3	0.36	55.1
	Std. Dev.	5.9	1.51	8.07	6.4	4.3	5.9	2.7	0.05	15.7
Brown Turkey	Commercial	50.4	2.02	39.29	40.9	14.9	14.3	13.6	0.38	36.2
	Std. Dev.	9.7	0.31	12.41	11.8	10.3	40.6	0.6	0.06	4.3
	Tree Ripe	56.7	1.89	27.56	39.1	14.1	2.7	15.6	0.29	55.3
	Std. Dev.	11.6	0.70	7.47	9.4	9.9	44.4	2.0	0.03	12.8
Kadota	Commercial	40.7	1.28	47.74	69.3	49.3	107.0	17.2	0.62	27.5
	Std. Dev.	6.7	0.13	3.62	6.7	5.1	6.7	-	-	-
	Tree Ripe	37.8	1.78	39.40	-	-	-	22.2	0.28	80.6
	Std. Dev.	11.1	0.52	5.75	-	-	-	-	-	-
Mission	Commercial	28.0	3.69	41.82	37.8	9.3	304.1	16.8	0.52	32.5
	Std. Dev.	3.0	2.36	7.06	5.7	6.6	41.5	-	-	-
	Tree Ripe	29.6	3.33	36.36	35.9	4.8	268.2	23.0	0.31	74.2
	Std. Dev.	9.0	1.27	8.99	3.6	1.9	86.3	-	-	-
Orphan	Commercial	42.9	2.03	35.88	74.4	50.6	107.2	12.9	0.26	50.3
	Std. Dev.	10.3	0.88	9.18	5.7	3.7	5.2	1.0	0.03	1.5
	Tree Ripe	44.5	3.35	42.42	76.4	52.6	101.8	14.9	0.21	73.9
	Std. Dev.	9.1	1.84	16.61	4.8	3.7	4.7	1.0	0.05	20.9
Panachee	Commercial	-	3.58	54.70	-	-	-	16.8	0.66	25.4
	Std. Dev.	-	1.11	7.69	-	-	-	0.6	0.01	1.3
	Tree Ripe	-	3.25	55.87	-	-	-	23.1	0.61	39.8
	Std. Dev.	-	0.85	12.61	-	-	-	0.1	0.20	13.1
UCR 276-14	Commercial	32.3	4.75	41.71	71.6	51.9	113.5	14.7	0.43	34.0
	Std. Dev.	6.9	1.87	13.40	5.8	3.2	4.3	0.4	0.02	0.9
	Tree Ripe	40.6	4.14	39.05	73.0	52.2	107.0	19.0	0.23	84.4
	Std. Dev.	10.8	2.30	8.81	5.3	3.9	4.4	0.0	0.03	11.4
UCR 291	Commercial	47.4	1.96	45.56	68.2	47.1	116.0	16.3	0.59	29.0
	Std. Dev.	11.4	0.74	5.95	7.3	4.0	4.4	0.1	0.18	9.1
	Tree Ripe	50.7	2.93	36.38	66.9	47.6	112.1	19.5	0.31	64.1
	Std. Dev.	11.5	0.97	12.54	4.6	3.7	3.8	2.1	0.03	13.7
White Texas Everbearing	Commercial	35.5	1.40	35.40	68.4	49.4	111.8	18.2	0.62	31.4
	Std. Dev.	10.5	0.44	11.15	6.4	5.7	5.6	3.1	0.18	14.0
	Tree Ripe	41.8	1.93	26.49	73.5	52.4	101.7	24.5	0.33	75.1
	Std. Dev.	16.6	1.10	7.66	5.5	5.1	5.5	0.8	0.03	4.1
Zidi	Commercial	59.0	2.28	36.32	40.3	6.2	322.9	17.2	0.62	28.3
	Std. Dev.	11.0	0.48	7.27	7.8	5.1	41.5	0.9	0.07	4.8
	Tree Ripe	57.8	1.41	24.92	37.9	4.3	294.9	24.0	0.40	59.7
	Std. Dev.	11.6	0.76	5.71	5.5	1.4	24.2	0.6	0.01	2.8

Table 2. Initial fruit quality attributes measured on 10 fig cultivars/selections harvested at commercial and tree ripe maturity stages at the ARS National Clonal Germplasm Repository (NCGR), Davis, in 2006.

Cultivar	Maturity stage	Weight (g)	Ethylene ($\mu L\ C_2H_4\ kg^{-1}\ h^{-1}$)	Respiration ($mL\ CO_2\ kg^{-1}\ h^{-1}$)	Color			SSC (%)	TA (% citric acid)	SSC:TA
					L	C	°H			
152-4s	Commercial	46.1	4.80	55.94	75.1	49.9	108.8	19.4	0.37	49.5
	Std. Dev.	10.6	1.03	7.38	4.0	3.4	2.8	0.5	0.05	7.5
	Tree Ripe	41.9	5.06	58.69	69.9	46.6	108.1	23.4	0.37	63.2
	Std. Dev.	12.6	1.06	20.71	6.7	4.1	4.4	3.7	0.05	11.0
Brown	Commercial	28.6	12.90	77.45	38.4	20.5	27.7	19.5	0.55	35.8
Turkey	Std. Dev.	6.1	1.58	5.20	9.2	6.6	20.4	0.6	0.06	4.6
	Tree Ripe	27.3	-	-	29.4	12.5	9.4	24.6	0.39	63.9
	Std. Dev.	5.8	-	-	3.7	6.0	18.0	1.4	0.04	9.4
Kadota	Commercial	28.3	11.80	65.67	72.9	54.1	106.8	20.6	0.22	97.0
	Std. Dev.	6.1	1.99	9.27	3.6	2.9	3.2	0.5	0.06	29.8
	Tree Ripe	28.4	8.62	46.22	74.0	55.4	102.3	26.8	0.14	188.4
	Std. Dev.	5.3	1.59	7.01	2.6	3.5	3.5	1.8	0.01	9.3
Mission	Commercial	23.2	17.05	79.66	32.0	5.4	318.6	22.9	0.84	95.4
	Std. Dev.	4.5	2.40	5.37	3.2	1.5	28.5	1.8	0.22	7.2
	Tree Ripe	18.6	10.67	78.67	31.9	4.4	284.7	26.7	0.54	33.2
	Std. Dev.	3.4	0.97	19.70	2.8	1.2	23.2	0.6	0.05	7.2
Orphan	Commercial	28.8	8.93	58.88	81.2	55.9	104.1	15.7	0.42	37.3
	Std. Dev.	5.7	1.60	8.28	3.4	3.5	3.3	2.1	0.04	2.8
	Tree Ripe	33.0	7.35	52.68	81.2	56.4	100.0	13.3	0.32	43.6
	Std. Dev.	6.9	0.46	6.88	4.1	3.5	2.9	1.2	0.08	13.6
Panachee	Commercial	36.8	13.70	61.01	83.3	53.9	99.0	23.7	1.10	22.3
	Std. Dev.	9.0	3.58	3.63	2.7	4.7	3.3	2.1	0.19	6.0
	Tree Ripe	35.9	7.95	55.09	73.8	44.4	93.5	31.5	0.83	41.9
	Std. Dev.	7.2	2.74	18.02	4.4	7.8	7.3	1.3	0.35	14.9
UCR	Commercial	38.0	7.70	57.97	77.6	52.6	107.0	17.7	0.42	42.2
276-14	Std. Dev.	8.3	1.34	7.91	3.9	3.3	2.3	1.1	0.04	6.1
	Tree Ripe	-	-	-	75.7	51.7	105.8	19.0	0.32	62.8
	Std. Dev.	-	-	-	5.3	3.4	2.4	1.6	0.10	16.7
UCR 291	Commercial	44.9	11.63	70.47	71.5	50.1	114.0	18.7	0.93	20.2
	Std. Dev.	13.5	4.44	17.88	6.1	2.9	3.0	0.6	0.04	1.3
	Tree Ripe	54.2	8.07	54.06	71.1	49.0	108.8	21.3	0.73	29.4
	Std. Dev.	14.7	4.36	13.91	6.0	4.7	2.3	0.8	0.04	2.1
White Texas	Commercial	23.7	9.05	53.52	72.5	48.3	95.6	27.5	0.24	180.4
Everbearing	Std. Dev.	5.9	0.02	10.30	7.1	10.7	8.0	3.3	0.02	60.9
	Tree Ripe	29.2	7.18	38.68	74.7	51.4	102.0	27.7	0.16	181.9
	Std. Dev.	10.7	1.58	2.97	5.2	7.5	7.2	0.7	0.03	31.1
Zidi	Commercial	51.0	7.81	54.79	33.1	5.5	340.5	23.9	0.35	69.4
	Std. Dev.	15.8	1.28	8.60	2.9	3.5	22.4	0.4	0.07	15.0
	Tree Ripe	53.3	3.58	34.81	35.3	3.6	311.9	27.0	0.28	96.4
	Std. Dev.	16.7	0.87	7.59	4.1	0.9	34.7	2.8	0.05	10.4

- No data available.

There was a significant positive relationship between the percentage of fruit with juice in the ostiole after 2 and 3 days of shelf life and the percentage of decayed fruit after 3 days of shelf life, R^2=0.66 and 0.64, respectively and p-values=0.000. The percentage of fruit with decay was not related to any other quality or physical parameter; not ostiole diameter, split ostiole, or skin thickness. Tree ripe fruit were generally more affected by off color (in most cases onset of decay) than fruit harvested at commercial maturity. 'Orphan' had the highest percentage of fruit with off color, while 'Mission' and 'Zidi' were less affected by off colors. The lower presence of off color in 'Mission' and 'Zidi' may be due to their darker purple skin making detection of atypical colors difficult. Juice in the ostiole was evaluated in 2006 only, and was not affected by fruit maturity at harvest. During the first 2 days after cold storage, UCR 291 had the highest percentage of fruit with juice in the ostiole, while 'Mission' and 'Panachee' had the lowest percentages. After 3 days of shelf life, 152-4s, 'Kadota', 'White Texas Everbearing', and UCR 291 had the highest percentages of fruit with juice in the ostiole. 'Mission', 'Brown Turkey', 'Panachee', and 'Orphan' had the lowest percentages of fruit with juice in the ostiole after 3 days of shelf life. The percentages of fruit with off color and juice in the ostiole were not related to any of the initial quality or physical parameters. In 2005, there was a higher percentage of fruit affected by growth cracks when harvested at tree ripe maturity than when harvested at commercial maturity. In 2006, harvest maturity stage did not affect the percentage of fruit with growth cracks. In 2005, 'Kadota' and 'Mission' had more fruit with growth cracks, and were the only two cultivars with growth cracks in fruit harvested at commercial maturity. In 2006, 152-4s and 'Zidi' had the most fruit with growth cracks. 'Panachee', 'White Texas Everbearing', and UCR 276-14 in 2005, and 'Orphan' and UCR 276-14 in 2006 did not have any growth cracks, independent of the maturity at harvest. The percentage of fruit with split ostioles was not affected by maturity stage. The cultivars with higher percentages of split ostioles were 'Zidi', in both seasons, and 'Kadota' in 2005. In 2005, the percentage of fruit with blemishes was generally unaffected by maturity at harvest. On the other hand, in 2006, figs harvested at tree ripe maturity had a higher percentage of blemished fruit than those harvested at commercial maturity. The cultivars with the highest percentages of blemished fruit were 'White Texas Everbearing' harvested at tree ripe maturity in 2005 and UCR 291 in 2006, while 'Mission' was the cultivar with the lowest percentage both seasons. The presence of growth cracks, split ostioles, and blemishes was not related to any initial quality or physical parameter, not even ostiole diameter or skin thickness. Parameters affected by maturity stage, such as firmness, SSC, TA, and shelf life, were also affected by season. Figs in 2006 had lower firmness, higher SSC, lower TA, and shorter shelf life than figs in 2005, following the same pattern as tree ripe fruit in comparison to commercial figs. On the other hand, the 2006 figs had higher ethylene production and respiration rates than figs in 2005, comparable to commercial versus tree ripe figs. These results suggest that in 2006 the figs were riper than 2005, possibly due to higher temperatures during transportation. This would have increase ethylene production and respiration rates precipitating deterioration-ripening.

The weight of the cultivars/selections from the NCGR, Davis, 20-60 g, was comparable to that reported for Turkish cultivars (Çalişkan and Polat, 2008). The cultivars studied also had similar fruit lengths, 41-63.5 mm to cultivars from Turkey, 38.5-62.0 mm, but were smaller in fruit diameter, 35.6-48.4 mm versus 45.0-55.0 mm. SSC of the cultivars studied, 13-31%, though more variable, were comparable to those of Turkish cultivars, 15.1-21%, 16-27%, and 20.1-27.4%. Finally, TA of the cultivars studied, 0.14-1.00% citric acid, was in general higher than that reported for cultivars from Turkey, 0.09-0.26%, 0.14-0.22%, and 0.06-0.15% (Çalişkan and Polat, 2008).

CONCLUSIONS

- Identifying high consumer quality figs with good flavor that remain firm during ripening and tolerate postharvest handling is critical to increase fresh fig consumption in U.S. and overseas.
- Detailed evaluation of fig genotypes currently in the major US collection identified few promising cultivars for fresh fig production indicating the need for a fig breeding

program focusing on fresh figs.
- A complementary search for better fresh fig genetic material is being conducted with potential genotypes from collections in Badajoz and Mallorca Spain for evaluations under California conditions.
- A fresh fig postharvest evaluation protocol is being developed to select genotypes suitable for high quality fresh fig production and marketing.
- Better methods of packing and marketing to protect fresh figs from human bacteria contaminations, reduce decay, improve fruit safety, and quality of this fresh commodity should be investigated.

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