

## POSTHARVEST INTERNAL AND EXTERNAL EVALUATION OF LB8-9 IN COMPARISON TO SUNBURST AND MINNEOLA

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**Abstract.** Effect of waxing on postharvest quality of LB8-9 fruit and acceptance for consumer were compared with Minneola and Sunburst during the season of 2002-2004. LB8-9 and Sunburst fruit stored two weeks at 22 °C developed similar decay percentages (36%), while Minneola showed only 16% decay. Pitting incidence was zero in LB8-9 and Minneola, and 3% in Sunburst tangerines. No differences were found in fruit color or postharvest losses among three cultivars stored at 4 °C after 6 weeks (data not shown). Wax formulation studies indicated that carnauba wax was the best formulation for coating LB8-9. Taste panels were conducted one week and 7 weeks after fruit were stored at 4 °C. No difference was found in fruit acceptance one week after packing, while a better score of acceptance was recorded for LB8-9 than Minneola after 7 weeks. Generally, LB8-9 was characterized by the panelists as having a rich flavor. LB8-9 fruit had higher Brix (14.2) and acid (1.12) than Minneola or Sunburst, both having a Brix and acid lower than 11.5 and 0.86, respectively.

In recent years, a strong demand has developed for increasing of fresh fruit production for the fresh fruit market. This increase has occurred primarily in specialty fruit, mainly mandarins and tangerines. The Florida Department of Citrus conducted a survey recently and summarized the consumer preferences for new cultivars. These preferences are seedlessness, ease of peeling, and good color (Morrissey, FDOC, personal communication). Satsuma mandarin and Clementine tangerine are two cultivars grown in Spain and Morocco that possess characteristics described above (Saunt, 2000). However, these two cultivars are not suitable for growth under Florida climatic conditions, and tend to produce fruit with poor color and internal quality (Davies and Albrigo, 1994).

LB8-9 is a new cultivar developed by Dr. Fred Gmitter and the cultivar development group at CREC. This new cultivar has been tested in commercial scale for many years. LB8-9 matures before Minneola and after Sunburst. The latter cultivar, Sunburst is characterized by good fruit color while the former, Minneola, has poor fruit color and is not fully mature until January. LB8-9 matures in December, which is suitable for the gift-fruit packing before Christmas. In addition, Minneola degenerates quickly if left on the tree and has a rather short marketing period. From a production viewpoint, LB8-9 is an excellent cultivar with a strong taste/ flavor, and well suited for fresh fruit market during the holiday season.

The objectives of this study are to systematically study the postharvest handling and storage of this cultivar, as well as evaluate the internal nutritional characteristics and flavor, to provide information for packers and shippers.

### Materials and Methods

*Study 1. Storage quality of LB8-9.* Fruit were received from a new cultivar development grove at CREC, Lake Alfred, on 30 Nov. 2002. Fruit were washed with commercial fruit cleaner (Sooty Mold Clean 278 Decco, Monrovia, Calif.), dried at 45 °C and waxed with carnauba, shellac, or polyethylene waxes (FMC Corporation, Lakeland, Fla.). A non-waxed treatment served as a control. Each treatment consisted of three replications with 45 fruit per replication. Fruit were examined for Chilling injury (CI) after 3 months of storage at 4 °C with 92-96% RH.

*Study 2. Postharvest quality of LB8-9 in comparison to Sunburst and Minneola.* LB8-9, Sunburst, and Minneola were harvested at CREC groves on 3 Dec. 2003. Fruit were washed as described in Study 1. After washing, fruit were waxed with Carnauba wax (FMC Corp., Lakeland, Fla.). There were 4 replicates for each cultivar with 60 fruit in each replication. Fruit were stored either at 22 °C or 4 °C, both at 92-96% RH, for postharvest evaluation.

*Disorder evaluation.* Postharvest pitting (PP) of fruit was rated visually (0 = no pits; 1 = 1 to 3 pits; 2 = 4 to 10 pits; 3 = 11 to 30 pits; 4 = 31 to 100 pits; and 5 = more than 100 pits) as described previously (Petracek et al., 1998), and collapsed clusters were counted. CI was rated by subjectively assigning each fruit a numerical rating of 0 (no damage), 1 (slight: <5% of fruit surface damaged), 2 (moderate, 5-49% of fruit surface damaged), or 3 (severe, 50-100% of fruit surface damaged; Dou, 2004). Percentage of CI for each replication within a treatment was calculated and statistically analyzed.

*Measurement of weight loss.* Weight was measured on day 1 and day 14. Weight loss was expressed as the percentage change in mass between measuring periods for 10 fruit per each treatment stored at 4 °C.

*Measurement of fruit color.* Fruit color were measured in 10 fruit using a Minolta Colorimeter. Tristimulus values (X, x, and y) were converted to chroma\* (0 = lowest intensity, 100 = greatest intensity), and hue angle (0° = red-purple, 90° = yellow, 180° = bluish-green, 270° = blue) according to McGuire (1992). Fruit juice color was measured in a Macbeth Color-Eye 3100 spectrophotometer (Kollmorch Instruments Corporation) according to Lee (2000).

*Taste Panel.* A taste panel was conducted at CREC taste panel laboratory on day 5 and day 50 with 25 panelists each time. Panelists were asked to score the juice on a scale of 1 to 9 on a 9-point preference scale.

*Statistical analysis.* Study 2 was a factorial design, and Study 1 was organized in a completely randomized design. Data were analyzed by factorial analysis and ANOVA, accordingly. Means were separated by Duncan's new multiple range test at  $p < 0.05$ .

### Results

*Study 1. Storage quality of LB8-9.* Wax application on LB8-9 significantly reduced CI and weight loss when fruit were stored at 4 °C for 90 d. No difference was found among the

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Table 1. Effect of wax type on postharvest quality of LB8-9.

Waxes	Chilling injury % <sup>a</sup>	Decay %	Wt loss %/day	Color h°
Non wax	32.1 b <sup>a</sup>	0.7 a	0.160 b	63.2 a
Polyethylene	7.7 a	4.9 b	0.081 a	66.0 b
Carnauba	8.4 a	1.7 a	0.071 a	63.0 a
Shellac	9.8 a	4.0 ab	0.085 a	63.7 ab

<sup>a</sup>Chilling injury and decay were examined at day 90, while color and wt loss were measured at day 40. Fruit were stored at 4 °C and 92-96% RH.

<sup>b</sup>Different letter in same column means significantly different at  $P < 0.05$ .

three wax types in protecting fruit from chilling development. However, decay was lowest in fruit that were not coated. CI is a more serious problem than decay development. Fruit color develops better in carnauba-waxed fruit than in polyethylene-waxed fruit (Table 1).

Fruit internal Brix did not change from day 0 to the week 12 measurement in polyethylene-waxed fruit. Surprisingly, Brix increased 2 units in non-waxed fruit from day 0 to week 12. Acid is decreased in all waxed treatments after 12-weeks storage in comparison to day 0 (Table 2).

*Study 2. Postharvest quality of LB8-9 in comparison to Sunburst and Minneola.* The results indicated that pitting and color are different at three different cultivars but are not significantly influenced by the type of wax application. Decay is significantly affected by wax and cultivar type. Among cultivars, PP is higher in Sunburst while it is lower in LB8-9 and Minneola. Decay was lowest in Minneola while Sunburst and LB8-9 had better color than Minneola. Among the three wax types, shellac waxed fruit resulted in the highest fruit decay incidence (Table 3). LB8-9 had a higher Brix, and acid than Sunburst or Minneola. Fruit internal acid decreased from day 0 through week 4 and into week 8, while changes in Brix and color were small during storage (Table 4). The taste panel did not indicate a consumer preference for LB8-9 above Sunburst or Minneola (Table 5).

## Discussion

Overall, LB8-9 has more positive attributes than Sunburst or Minneola. For example, postharvest pitting is lower in LB8-9 than Sunburst (Table 3). In particular, fructose is 30% higher in LB8-9 (3.01 g 100 mL<sup>-1</sup>) than Sunburst (2.19 g 100 mL<sup>-1</sup>) and Minneola (2.32 g 100 mL<sup>-1</sup>, Dou, unpublished Data). Sunburst and Minneola have been marketed as gift fruit during December and January and the results show that LB8-9 has all positive postharvest characteristics of these two varieties.

The storage study indicated a slow decrease in acid in LB8-9 fruit. This is particularly true if fruit were waxed with

Table 2. Effect of wax type on internal quality of LB8-9.<sup>a</sup>

Wax type	In storage weeks	Brix	Acids (%)
Non wax	0	12.4 b <sup>a</sup>	0.98 d
Non wax	12	14.0 d	0.84 c
Polyethylene	12	12.4 b	0.74 a
Carnauba	12	12.6 c	0.77 b
Shellac wax	12	12.1 a	0.73 a

<sup>a</sup>Fruit were stored at 4 °C and 92-96% RH.

<sup>b</sup>Different letter in same column means significantly different at  $P < 0.05$ .

Table 3. Postharvest storage quality of LB8-9, Sunburst and Minneola.<sup>a</sup>

Variable	Pitting	Decay	Color
Cultivar	*** <sup>y</sup>	***	***
Wax type	NS <sup>x</sup>	***	NS
Interaction	NS	*	NS
Mean separation			
	Pitting (%)	Decay (%)	Color (h°)
LB8-9	0	35	60.7
Sunburst	2.9	37	60.7
Minneola	0	16	65.1
Carnauba	NS	20	NS
Polyethylene	NS	30	NS
Shellac	NS	38	NS

<sup>a</sup>Fruit were stored at 22 °C and 92-96% RH for 2 weeks.

<sup>y</sup>Significant different at  $P < 0.05$ , or 0.001, respectively.

<sup>x</sup>NS = not significant.

carnauba rather than shellac wax. Shellac waxed fruit results in fruit internal and external quality deterioration as shown in this paper (Tables 1 and 2). The cause is the lower gas permeability of shellac-waxed fruit than fruit waxed with carnauba or polyethylene (Dou, 2004; Hagenmaier and Shaw, 1992). The positive aspects of wax application result in reductions in fruit chilling injury, protect fruit from weight loss, and have been discussed by Dou and Ismail (2000) and Petracek et al. (1998).

There is a trend to increased Brix and decreased acidity during storage in all varieties. It is more obvious in LB8-9 and Sunburst than in Minneola. Echeverria and Ismail (1987) found an increase in Brix in 'Hamlin' oranges and 'Robinson' tangerines during 9 weeks of storage at 15 °C.

Table 4. Fruit internal quality in storage among three cultivars.<sup>a</sup>

Cultivar	In storage weeks	Brix	Acids (%)
Sunburst	0	11.5	0.86
	4	11.7	0.74
	8	12.0	0.71
LB8-9	0	14.0	1.12
	4	14.4	0.90
	8	14.6	0.86
Minneola	0	11.2	0.86
	4	11.4	0.85
	8	11.5	0.76

<sup>a</sup>Fruit were stored at 4 °C and 92-96% RH.

<sup>b</sup>Significant difference at  $P < 5\%$ .

Table 5. Taste panel results among three varieties.<sup>a</sup>

Variety	Day 6 (n = 19)	Day 50 (n = 17)
LB8-9	7.3 a	6.6 a
Sunburst	7.3 a	7.3 b
Minneola	7.3 a	6.5 a

<sup>a</sup>Score between 1-9 were used. Nine represents the most liked, while one represents the extremely disliked.

Different letter in same column means significantly different at  $P < 0.05$ .

LB8-9 behaves similarly to Minneola, developing lower pitting and decay than Sunburst among the three varieties. However, no flavor difference was found between the three cultivars. Overall, LB8-9 did not show any serious postharvest problems, and it is well suitable for fresh fruit market.

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