



**PEAK** *fresh*<sup>®</sup>

**"The Best Pallet Covers Without CO2"**

# **Strawberry Test Report**

**September 2012**

**Comparison of the Efficacy of the PEAKfresh<sup>®</sup> and Tectrol<sup>®</sup> Systems for Maintaining Strawberry Quality**



## Strawberry Test Report

### Executive Summary

In September 2012, PEAKfresh®USA engaged the Horticulture and Crop Science Department at Cal Poly, San Luis Obispo, to conduct a test entitled, “**Comparison of the Efficacy of the PEAKfresh® and Tectrol® Systems for Maintaining Strawberry Quality.**” The test, which is included in its entirety hereafter, was conducted to provide an objective, scientific, third-party review of the effectiveness of each Modified Atmosphere Packaging (MAP) system (PEAKfresh® pallet<sup>1</sup> covers vs. TransFresh Tectrol® CO<sub>2</sub> pallet covers) in maintaining the freshness of strawberries in cross-county shipment from Castroville, CA to New York terminal market.

This report summary also includes four USDA Inspection Certificates. The USDA inspections were performed by the same inspector. Strawberry quality and condition as well as pulp temperatures were examined at shipping point (Castroville, CA) as well as at final destination (Bronx, NY). USDA Inspection Certificates are commercially accepted standards for the grading of fresh produce.

#### Competing MAP Systems Overview<sup>2</sup>

Modified Atmosphere Packaging systems have been in use for prolonging the shelf-life period of fresh produce for over 40 years. MAP systems typically use a sealed package that changes the air surrounding the produce by reducing the O<sub>2</sub>-level and increasing the CO<sub>2</sub>-level. In doing so the ripening of fruits and vegetables can be delayed, respiration and ethylene product rates can be reduced, softening can be retarded and various compositional changes associated with ripening can be slowed down.

Fruits and vegetables are respiring products where the interaction of the packaging material with the product is important. If the permeability (for O<sub>2</sub> and CO<sub>2</sub>) of the packaging film is adapted to the products respiration, an equilibrium modified atmosphere will establish in the package and the shelf-life of the product will increase. This kind of package slows down the normal respiration of the product to prolong its shelf-life. Among fresh-cut produce Equilibrium Modified Atmosphere Packaging (EMAP) is the most commonly used packaging technology.

Tectrol® CO<sub>2</sub> Systems are an EMAP solution to prolonging shelf-life. In comparison, PEAKfresh® is also an EMAP solution, but is instead unsealed and gas-free, relying upon packaging that is impregnated with an all-natural mineral film that removes and absorbs ethylene gas – the catalyst for the ripening process in fruits and vegetables. Besides the all-natural mineral, PEAKfresh® contains an anti-fogging treatment that removes moisture formation, inhibiting mold and bacteria growth, while simultaneously maintaining a high-humidity environment so fruits and vegetables do not dehydrate.

Although both competing systems – PEAKfresh® and Tectrol® – were developed to ensure that shipped produce arrives at its destination fresh and safe, the main difference is that one uses a sealed package system (Tectrol®) with CO<sub>2</sub> gas, while the other (PEAKfresh®), uses a system that does not require a sealed package or CO<sub>2</sub> gas.

<sup>1</sup> PEAKfresh® pallet covers are an unsealed Modified Atmosphere Packaging system.

## The Test Results

Pallets of “Albion” Strawberries – a variety noted for large size, firmness, and resistance to certain diseases – were treated to the Tectrol® systems or covered with PEAKfresh® strawberry pallet bags and inspected by the USDA at a packing/shipping facility in Castroville, CA and then inspected again by the USDA at a warehouse in the Bronx, NY four and a half days later.

The test - “**Comparison of the Efficacy of the PEAKfresh® and Tectrol® Systems for Maintaining Strawberry Quality**” - concludes upon arrival that:

1. PEAKfresh® treated pallets had a lower temperature rating than the Tectrol® treated pallets during cross-country shipment.
2. Berries in PEAKfresh® treated pallets were softer on average than berries in Tectrol® treated pallets during cross-country shipment.
3. There were no differences in color or weight loss of the berries resulting from the pallet treatments during cross-country shipment.

The management of PEAKfresh® assembled its own internal team to review the results, protocol and methodology of the test that indicated berries in PEAKfresh® treated pallets were “softer on average” than berries in Tectrol® treated pallets to determine what resulted in the difference between the two systems’ effect on firmness.

### Conclusion

It was found that pallets of strawberries for the test were picked and delivered to the packing/shipping facility at the same time and inspected by the USDA after product was pre-cooled. Pulp temperatures at the shipping facility were the same for both labels. After arriving at the Bronx, NY both the Tectrol® system – Sweet Darling Brand and PEAKfresh®-White horse brand were unloaded together. After unloading, The USDA inspector inspected both lots of berries. The pulp temperatures were the same for both lots. The TECTROL® treated bags were removed shortly after CO<sub>2</sub> verification and the PEAKfresh® pallet covers stayed on the fruit for several hours until inspection by the Cal Poly team could occur after the examination of the Tectrol® berries. Temperature monitors were installed in the berry fields in Castroville. Monitors were installed in three boxes per pallet. The monitors clearly depict the elevation in pulp temperatures of 10-15 degrees in the PEAKfresh® berries.

The Cal Poly team did not conduct pulp temperatures before or during firmness testing.

***This elevation in pulp temperatures is why we believe the firmness of the berries when tested by the Cal Poly team were different.*** As noted on the USDA inspections, there was no significant difference in bruising on arrival. ***If berries were noticeably softer in one treatment over the other, the USDA inspection should have shown more bruising.***

Although an oversight of the Horticulture and Crop Science Department at Cal Poly, San Luis Obispo in conducting the test, ***PEAKfresh® recommends that future tests include a more specific protocol for ensuring that pulp temperatures prior to firmness testing be conducted so that temperature can be eliminated as a variable in the measure of fruit firmness between the two competing systems. We also recommend that decay is measured when comparing the efficacy of the two systems - an attribute not identified by the Cal Poly test but denoted by the USDA.***



# **Comparison of the Efficacy of the PEAKfresh<sup>®</sup> and Tectrol<sup>®</sup> Systems for Maintaining Strawberry Quality**

## **The Report**

September, 2012

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# Comparison of the Efficacy of the PEAKfresh<sup>®</sup> and Tectrol<sup>®</sup> Systems for Maintaining Strawberry Quality

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## Introduction

A comparative study was performed evaluating the effects of the PEAKfresh strawberry pallet bag and the Tectrol system on the temperature of strawberries, changes in berry firmness and color, and weight loss from the berries during cross-country shipment from Castroville, California to the New York City Produce Terminal Market at Hunts Point, the Bronx. Carbon dioxide and oxygen levels in the pallets were measured before and after shipment, as was the temperature of the truck air surrounding the pallets during shipment.

## Methodology

The experiment was begun on September 20th and ended September 24. Fourteen pallets of 'Albion' strawberries were used in the study. Seven pallets were subjected to the conventional method of bagging, sealing and CO<sub>2</sub> injection per the Tectrol<sup>®</sup> protocol (Transfresh Corporation, Salinas, CA). Seven pallets were overwrapped but not sealed with PEAKfresh<sup>®</sup> strawberry pallet bags (PEAKfresh<sup>®</sup>, USA, Lake Forest, CA). The pallets were shipped via commercial transport from Castroville, California beginning midnight of the 20th. The pallets arrived at the NYC Produce Terminal Market at Hunts Point in the Bronx, New York at 4:00 a.m., Monday, the 24<sup>th</sup> and final measurement of the berries was begun at 8:00 a.m.

Each pallet consisted of 18 levels with 6 flats per level and 8 clamshells per flat. Four flats each from layers 3 (Bottom), 9 (Middle) and 15 (Top), as counted from the bottom of the stack (Fig. 1), were randomly selected from each pallet and, from each flat, four clamshells were randomly selected. The flats were numbered per the scheme directly below and this pattern was repeated consistently for all flats, i.e., the numbering of the flats and orientation of the flats on the pallets was always the same.

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<b>Flat 2</b>	<b>Flat 4</b>	<b>Flat 6</b>
<b>Flat 1</b>	<b>Flat 3</b>	<b>Flat 5</b>

Clamshells within a flat were numbered per the scheme directly below and this pattern was repeated consistently for all clamshells, i.e., the number of the clamshells within a flat and the orientation of the clamshells with a flat was always the same.

<b>Clamshell</b> 2	<b>Clamshell</b> 4	<b>Clamshell</b> 6	<b>Clamshell</b> 8
<b>Clamshell</b> 1	<b>Clamshell</b> 3	<b>Clamshell</b> 5	<b>Clamshell</b> 7





Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
9	Bottom	5	7		10	Bottom	1	2
9	Bottom	6	2		10	Bottom	1	8
9	Bottom	5	8		10	Bottom	1	5
9	Bottom	4	4		10	Bottom	2	6
Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
11	Top	2	2		12	Top	4	8
11	Top	1	1		12	Top	2	4
11	Top	1	7		12	Top	3	3
11	Top	6	2		12	Top	6	1
Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
11	Middle	2	6		12	Middle	1	4
11	Middle	3	6		12	Middle	4	6
11	Middle	5	8		12	Middle	1	5
11	Middle	3	7		12	Middle	4	1
Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
11	Bottom	2	4		12	Bottom	1	3
11	Bottom	2	6		12	Bottom	1	8
11	Bottom	1	4		12	Bottom	6	5
11	Bottom	2	8		12	Bottom	1	5
Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
13	Top	1	2		14	Top	3	1
13	Top	4	4		14	Top	2	2
13	Top	3	3		14	Top	1	5
13	Top	1	3		14	Top	2	4
Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
13	Middle	4	4		14	Middle	3	1
13	Middle	4	2		14	Middle	6	5
13	Middle	4	6		14	Middle	6	2
13	Middle	5	8		14	Middle	2	3
Pallet					Pallet			
Number	Location	Flat	Clamshell		Number	Location	Flat	Clamshell
13	Bottom	2	5		14	Bottom	6	7
13	Bottom	3	6		14	Bottom	2	1
13	Bottom	1	2		14	Bottom	4	4
13	Bottom	6	2		14	Bottom	6	6



Fig. 1. Pallet showing number of stacks from bottom to top. The pallet number, "6," is visible on the pallet itself on the lower left corner.

The clamshells were weighed before and after shipment to determine water loss. Three sound fruit from each clamshell were then selected randomly, labeled and the firmness and color of each berry were measured. Firmness was measured using an International Petroleum Institute (IPI) Penetrometer fitted with a press pad to be non-destructive (Fig. 2). Berry firmness was measured as deflection in 0.1 millimeters when 500g of weight was applied for 5 seconds on the shoulder (widest point) of the fruit. Color was determined by using a Minolta CR-400 Colorimeter. Each strawberry was measured at the shoulder, i.e., at the widest point of each berry, at 3 points equidistant around the fruit. Values were recorded as “\*L, \*a, \*b” where “\*L” indicated lightness, “\*a” indicated the degree of redness and “\*b” indicated the degree of yellowness of each fruit. The same labeled berries were also measured for firmness and color after shipment and, due to the labeling, the firmness was measured at the same point on each fruit, i.e., each fruit was measured for firmness at the beginning and end of the experiment at the location of the label.

To measure CO<sub>2</sub> and O<sub>2</sub> levels in all pallets, small Illinois Instrument (Johnsburg, IL) self-sticking package septa were placed on the Tectrol<sup>®</sup> and PEAKfresh<sup>®</sup> bags at levels 3, 9 and 15 as counted from the bottom of each stack. Numerous postharvest studies at Cal Poly have proven that these septa reseal highly consistently. In fact, in a 2008 series of experiments conducted for CO<sub>2</sub> Technologies, West (San Luis Obispo, CA), the same septa were used to measure the CO<sub>2</sub> and O<sub>2</sub> levels within pallets subjected to the Tectrol<sup>®</sup> system. Measurements were made daily over a period of 10 days and there was no evidence that the septa leaked.

CO<sub>2</sub> and O<sub>2</sub> levels were measured using a calibrated Illinois Instrument 6600 headspace analyzer factory configured for a CO<sub>2</sub> range of 0-25% and outfitted with a 3-inch sampling syringe (Fig. 3). Sampling volume was 50 ml which was found to be sufficient to produce a stable reading. CO<sub>2</sub> and O<sub>2</sub> levels were measured within 30 minutes of a pallet being subjected to the Tectrol<sup>®</sup> system. All pallets were measured for CO<sub>2</sub> and O<sub>2</sub> on 9/20 and after transportation, on 9/24. After CO<sub>2</sub> and O<sub>2</sub> levels were determined on 9/24, pallet covers were removed and the strawberries were sampled. No attempt was made by the receiver to reclaim carbon dioxide from the Tectrol<sup>®</sup> treated pallets.

Before shipping, PakSense Ultra-compact Labels (Paksense, Boise, ID) were placed in each pallet at levels 3, 9 and 15 as counted from the bottom of the stacks. Each Label was placed at the center of each layer.

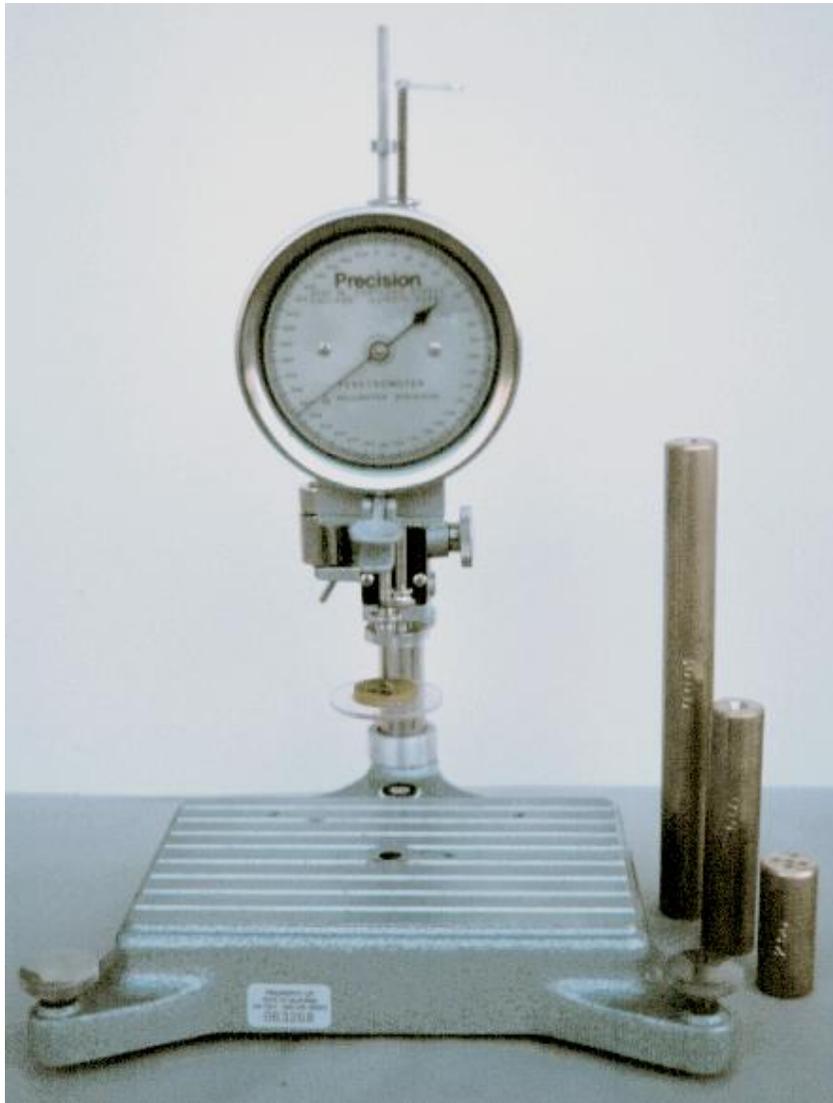


Fig. 2. Modified IPI Penetrometer used to non-destructively measure the firmness of strawberry fruit. Please note the press pad used to measure deflection of the fruit caused by weight.



Fig. 3. Gas sampling from pallet treated with the Tectrol<sup>®</sup> system. Self-sticky resealable septa are visible at levels 3 and 9 on the pallet.

At the time of loading, the 14 pallets were randomly placed at the back of the trailer (Table 1; Fig. 4). A TempTale<sup>®</sup> 4 temperature recorder (Sensitech, Beverly, MA) was placed on the sidewalls to either side of the double line of pallets at a point midway between the trailer floor and ceiling and midway between the beginning and end of the pallets. Three TempTale<sup>®</sup> 4 sensors were also placed on top of the pallets, at rows 2, 4 and 6 (Fig. 5). A total of 5 TempTale<sup>®</sup> 4 sensors were therefore used to recorder air temperature during transit.

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Table 1. Pallet-treatment pattern within truck trailer, September 20<sup>th</sup>.

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Pallet Number	Treatment	Treatment	Pallet Number
1	PEAKfresh <sup>®</sup>	PEAKfresh <sup>®</sup>	4
5	PEAKfresh <sup>®</sup>	Tectrol <sup>®</sup>	2
10	Tectrol <sup>®</sup>	PEAKfresh <sup>®</sup>	13
8	PEAKfresh <sup>®</sup>	Tectrol <sup>®</sup>	3
7	Tectrol <sup>®</sup>	Tectrol <sup>®</sup>	9
14	Tectrol <sup>®</sup>	PEAKfresh <sup>®</sup>	11
12	PEAKfresh <sup>®</sup>	Tectrol <sup>®</sup>	6

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Fig. 4. Pallets of strawberries placed in pre-cooled trailer. The pallets have been overwrapped with PEAKfresh<sup>®</sup> strawberry pallet bags. Note that the bags are not sealed at the bottom and are open to airflow.

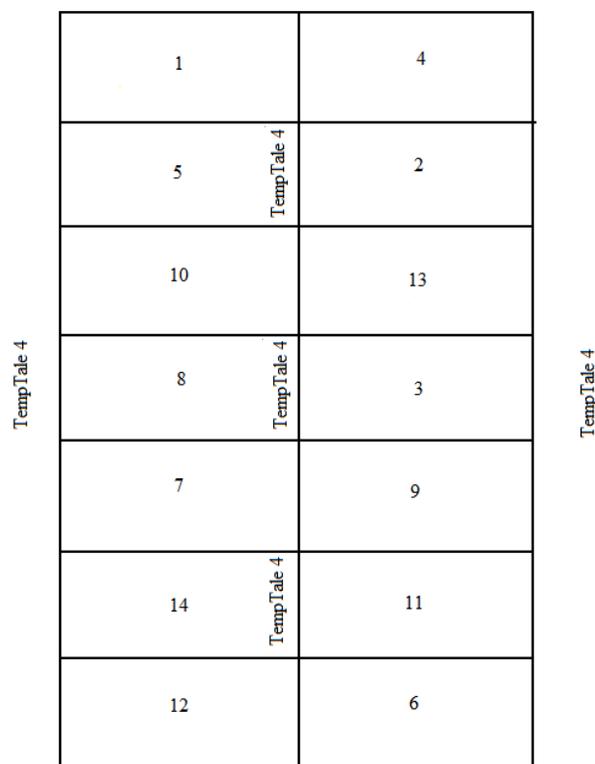


Fig. 5. Placement of TempTale<sup>®</sup> 4 temperature recorders in truck trailer. The TempTales on the left and right sides of the pallet stacks were placed on the sidewalls midway between the floor and ceiling of the trailer. Three TempTales were taped to the top of the pallets near the center of the 2 lines of pallets.

### Data Preparation

Data were collected on September 20<sup>th</sup> and after shipment, on September 24<sup>th</sup>. A difference was computed as the value collected on September 24<sup>th</sup> minus the value collected on September 20<sup>th</sup>, for every pair of measurements. For firmness and color, differences were computed for each berry. For weight, differences were computed for each clamshell. Temperature data was collected using one sensor at each of 3 levels within each pallet for a total of 42 temperature profiles.

For firmness, differences were computed as the September 24<sup>th</sup> deflection value minus the September 20<sup>th</sup> deflection value (in 0.1 mm), so positive values indicated a loss of firmness. For color (\*L, \*a, \*b) and weight, differences were also computed as the September 24<sup>th</sup> value minus the September 20<sup>th</sup> value. For these variables, negative differences indicated a reduction in the variable (*e.g.*, a negative weight change equated to weight loss) during shipment.

To facilitate statistical analysis, all data were averaged resulting in one value per level (three values per pallet). For individual berry differences, 12 berries per level were averaged. For weight differences, four clamshells per level were averaged. For the 14 pallets, the final data set contained up to 42 data values.

Temperature data consisted of many measurements throughout the shipping period. The analysis required a single temperature value at each of the 42 pallet levels. To accomplish this, a common time point in the middle of the shipment, 12:01am on September 22<sup>nd</sup>, was chosen as a “snapshot” of all temperature measurements. This time was selected as it was far enough from the beginning and end of the temperature measurements to avoid noise in the data.

### **Analysis**

A repeated measures analysis of variance (ANOVA) was performed in SAS Version 9.2 using the PROC MIXED command. A repeated measures analysis is necessary whenever multiple non-randomized observations are made within a single subject. In this case, pallets were the “subjects” to which the overall treatment (PEAKfresh<sup>®</sup> or Tectrol<sup>®</sup>) was applied.

Each repeated measures ANOVA tested a different response variable (temperature, firmness, \*L, \*a, \*b, weight, and percent weight). For all variables except temperature, the values were averaged differences between the September 24<sup>th</sup> readings and the September 20<sup>th</sup> readings. For each response variable, three possible effects were tested: a treatment effect (PEAKfresh<sup>®</sup> vs. Tectrol<sup>®</sup>), a level effect (top vs. middle vs. bottom of pallet), and a treatment-by-level interaction (to see if treatment effects changed for different levels within a pallet). Each effect was tested using a 1% individual significance level.

### **Results**

*Temperature.* The PEAKfresh<sup>®</sup> treated pallets had a lower average temperature during shipment than the Tectrol<sup>®</sup> treated pallets ( $p = 0.0059$ ). In the experiment, PEAKfresh<sup>®</sup> treated pallets had an average temperature (at 12:01am on 9/22) of 0.96° C. (33.7° F), while Tectrol<sup>®</sup> treated pallets had an average temperature of 1.44° C (34.6° F) (Fig. 6).

Overall, the pallets tended to be coldest at the top, followed by the middle, then the bottom, regardless of pallet treatment (Fig. 7). Temperatures at the pallet surface as measured by the TempTale<sup>®</sup> 4 recorders, at least on the top of the pallets, was in the 31-35° F range but sidewall temperatures were much higher, ranging from 31.5-41.5° F (Fig. 8).

*Changes in Firmness.* Though of the same variety, the strawberries used in this study were harvested from 2 close-by fields rather than from the same field. As a result, initially, the berries packaged and used with the Tectrol<sup>®</sup> system – from one field – were significantly softer than the berries overwrapped with the PEAKfresh<sup>®</sup> bags – from the other field. The Tectrol<sup>®</sup> berries initially compressed, on average, 6.36 units while the PEAKfresh<sup>®</sup> berries only 3.04 units ( $p > 0.002$ ).

Since a change in firmness after shipment was measured as the amount that a berry could be compressed on September 24<sup>th</sup> minus the amount of compression on September 20<sup>th</sup>, positive values on the 24<sup>th</sup> indicated that firmness had decreased during shipment. There was strong evidence ( $p < 0.0001$ ) that during shipment, berries in the PEAKfresh<sup>®</sup> treated pallets became softer than berries in the Tectrol<sup>®</sup> treated pallets. On average, PEAKfresh<sup>®</sup> treated berries became softer by 1.46 units (as measured in 0.1 mm deflection units) during shipment while Tectrol<sup>®</sup> treated berries became 3.87 units firmer. As an interesting consequence of this effect, in this experiment, since the berries were not of equal firmness initially, they became closer in firmness during shipment.

Previous research has found that strawberries increase in firmness when subjected to an elevated level of CO<sub>2</sub> during cold storage (Zhang and Watkins, 2005; Watkins et al., 1999; Laresen and Watkins, 1995; Smith, 1992; Smith and Skog, 1992; Plocharski, 1982). When 'Jewel' strawberries were subjected to 20% CO<sub>2</sub> at 2° C (35.6° F), firmness was significantly increased within 24 hours but did not increase further as storage continued (Zhang and Watkins, 2005). Similarly, Smith and Skog (1992) subjected 25 varieties of strawberry to 15% CO<sub>2</sub> and 18.5% O<sub>2</sub> at 0.5° C (32.9° F) and found that 21 of the 25 varieties were significantly firmer after 42 h compared to untreated controls. Watkins et al. (1999) subjected seven strawberry varieties to 20% CO<sub>2</sub> at 2° C (35.6° F) and found that firmness was increased for all

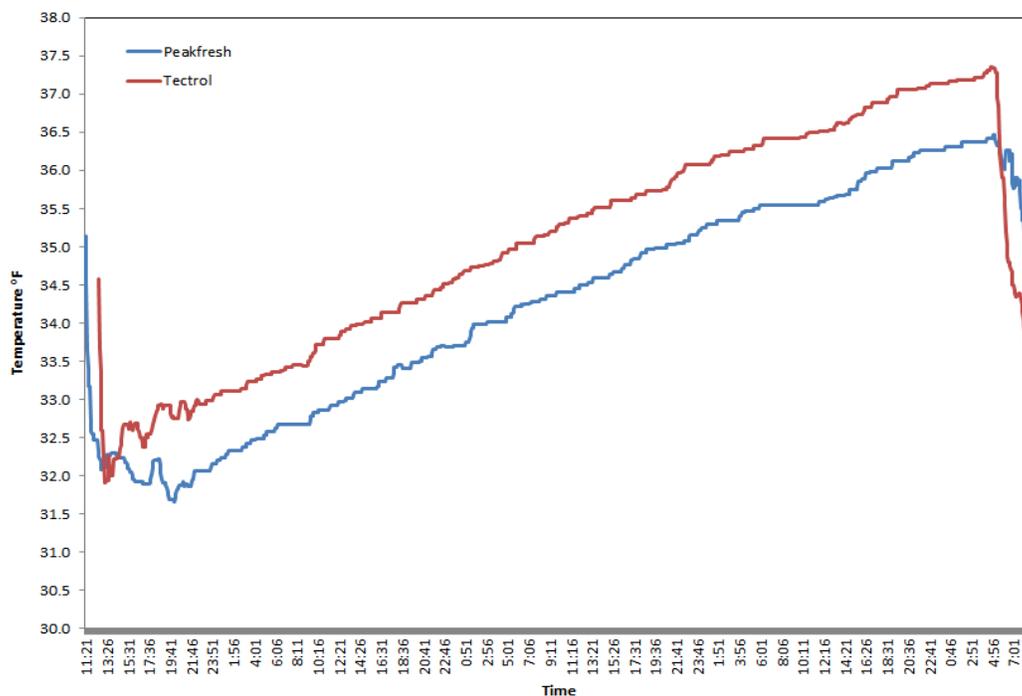


Fig. 6. Average temperatures of strawberry pallets subjected to the Tectrol® system or overwrapped with PEAKfresh® strawberry pallet bags.

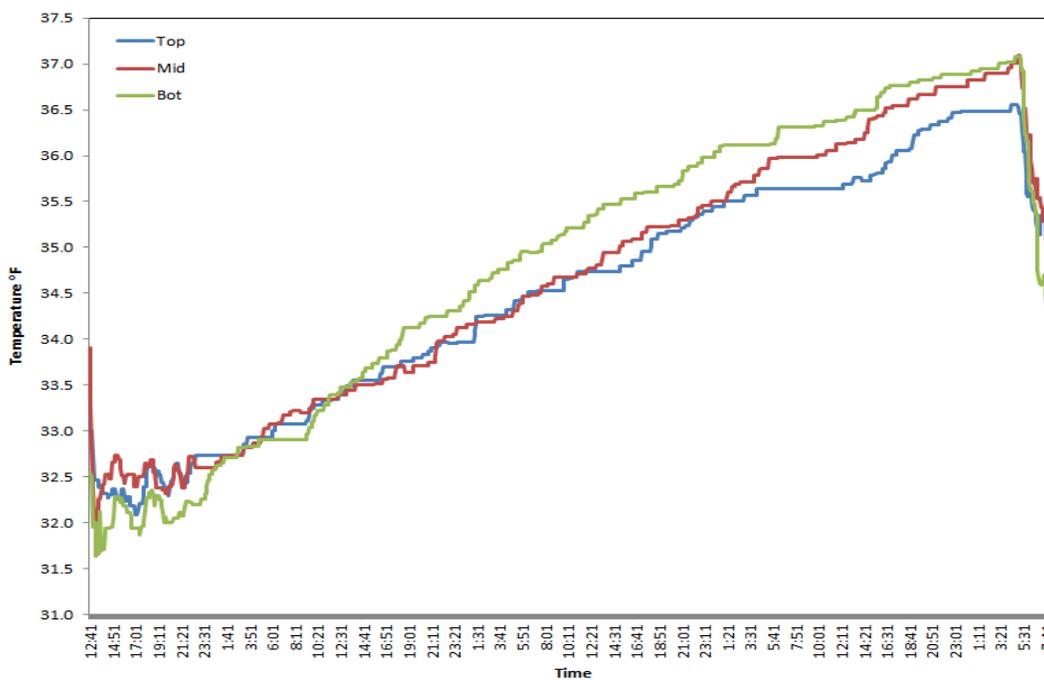


Fig. 7. Average temperatures with pallets of strawberries, regardless of pallet treatment (PEAKfresh® vs. Tectrol® system). Temperatures were recorded at level 3 from the pallets (bottom), level 9 (middle) or level 15 (top).

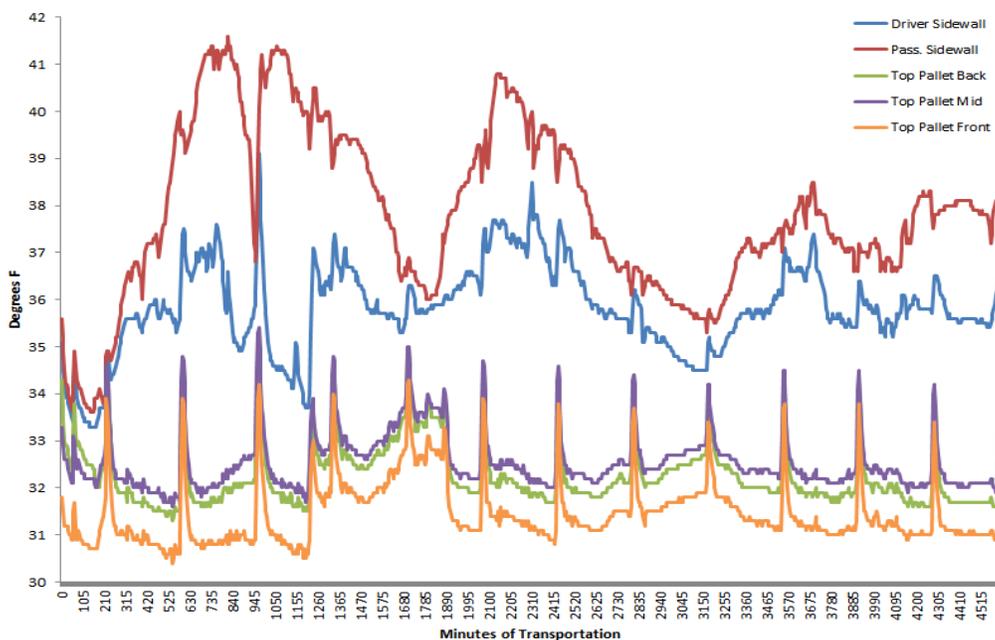


Fig. 8. Temperatures as recorded by TempTale<sup>®</sup> 4 sensors placed around or on 14 pallets of strawberries.

varieties but that the amount of increase was affected by variety and the number of days of storage. The color of CO<sub>2</sub>-treated fruit was not affected by storage in 20% CO<sub>2</sub> at 2<sup>o</sup> C (35.6<sup>o</sup> F)(Zhang and Watkins, 2005; Watkins et al., 1999).

There was some evidence ( $p = 0.0203$ ) to suggest that the effect of the pallet treatments on firmness loss changed slightly from level to level within a pallet (Table 2). The results indicated that regardless of level within the pallet, the PEAKfresh<sup>®</sup> treated berries grew softer during shipment while the Tectrol<sup>®</sup> treated berries grew firmer during shipment. While the differences between the treatments were statistically significant (as shown by the grouping letters), the differences between the levels (top, middle, bottom) within the pallets were not statistically significant at the 1% significance level.

*Other Analyses.* Analyses of color (\*L, \*a, \*b values) and weight (as both absolute loss and percentage loss) could not detect any differences (at the 1% significance level) between the berries shipped with the Tectrol<sup>®</sup> or PEAKfresh<sup>®</sup> systems.

Table 2. Loss of firmness due to pallet treatment and at 3 levels within the pallets during cross-country shipment of strawberries.

Treatment	Level	Average Firmness Loss (0.1 mm)	Grouping <sup>z</sup>
PEAKfresh <sup>®</sup>	Middle	2.40	a
PEAKfresh <sup>®</sup>	Bottom	1.20	a
PEAKfresh <sup>®</sup>	Top	0.77	a
Tectrol <sup>®</sup>	Top	-3.43	b
Tectrol <sup>®</sup>	Bottom	-3.92	b
Tectrol <sup>®</sup>	Middle	-4.25	b

<sup>z</sup> Averages with the same grouping letter are not significantly different at the 1% confidence level.

*Oxygen/Carbon dioxide Levels.* When initially tested, Tectrol<sup>®</sup> treated pallets contained, on average, 12.80% carbon dioxide based on three measurements at flat levels 3, 9 and 15 for each pallet (Table 3). After transport, none of the 7 Tectrol<sup>®</sup> treated pallets had maintained a modified atmosphere and carbon dioxide levels had reduced to an average 0.77%. In contrast and as expected, PEAKfresh<sup>®</sup> treated pallets were very low in carbon dioxide level (~0.10%), both initially and after transport, as the bags are not sealed and are open at the bottom to the transport and storage environments.

Table 3. Carbon dioxide and oxygen levels in pallets treated with the Tectrol<sup>®</sup> system or covered with PEAKfresh<sup>®</sup> strawberry bags, before and after transit.

Treatment	Pallet #	Location	CO <sub>2</sub>				O <sub>2</sub>			
			20-Sep	24-Sep	Absolute Change in Pallet	% Change	20-Sep	24-Sep	Absolute Change in Pallet	% Change
PEAKfresh <sup>®</sup>	1	Top	0.1	0.3	0.2	200.0	20.9	20.0	-0.9	-4.3
PEAKfresh <sup>®</sup>	1	Middle	0.1	0.0	-0.1	-100.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	1	Bottom	0.1	0.0	-0.1	-100.0	20.9	20.3	-0.6	-2.9
PEAKfresh <sup>®</sup>	4	Top	0.1	0.2	0.1	100.0	20.9	20.3	-0.6	-2.9
PEAKfresh <sup>®</sup>	4	Middle	0.1	0.0	-0.1	-100.0	20.9	20.3	-0.6	-2.9
PEAKfresh <sup>®</sup>	4	Bottom	0.0	0.0	0.0	0.0	20.9	20.3	-0.6	0.0
PEAKfresh <sup>®</sup>	5	Top	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	5	Middle	0.1	0.1	0.0	0.0	20.9	20.1	-0.8	-3.8
PEAKfresh <sup>®</sup>	5	Bottom	0.0	0.0	0.0	0.0	20.9	20.3	-0.6	0.0
PEAKfresh <sup>®</sup>	8	Top	0.1	0.1	0.0	0.0	20.9	20.1	-0.8	-3.8
PEAKfresh <sup>®</sup>	8	Middle	0.1	0.2	0.1	100.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	8	Bottom	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	11	Top	0.2	0.1	-0.1	-50.0	20.9	20.0	-0.9	-4.3
PEAKfresh <sup>®</sup>	11	Middle	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	11	Bottom	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	12	Top	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	12	Middle	0.1	0.0	-0.1	-100.0	20.9	20.3	-0.6	-2.9
PEAKfresh <sup>®</sup>	12	Bottom	0.1	0.0	-0.1	-100.0	20.9	20.3	-0.6	-2.9
PEAKfresh <sup>®</sup>	13	Top	0.1	0.1	0.0	0.0	20.9	20.3	-0.6	-2.9
PEAKfresh <sup>®</sup>	13	Middle	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
PEAKfresh <sup>®</sup>	13	Bottom	0.1	0.1	0.0	0.0	20.9	20.2	-0.7	-3.3
Average			0.10	0.09			20.90	20.21		

Table 3. Carbon dioxide and oxygen levels in pallets treated with the Tectrol<sup>®</sup> sytem or covered with PEAKfresh<sup>®</sup> strawberry bags, before and after transit (continued).

Treatment	Pallet #	Location	20-Sep	24-Sep	Absolute	% Change	20-Sep	24-Sep	Absolute	% Change
			CO <sub>2</sub>	CO <sub>2</sub>	Change in Pallet		O <sub>2</sub>	O <sub>2</sub>	Change in Pallet	
Tectrol <sup>®</sup>	2	Top	4.0	0.5	-3.5	-87.5	19.7	19.9	0.2	1.0
Tectrol <sup>®</sup>	2	Middle	13.5	0.5	-13.0	-96.3	17.6	19.8	2.2	12.5
Tectrol <sup>®</sup>	2	Bottom	21.5	0.5	-21.0	-97.7	15.7	19.8	4.1	26.1
Tectrol <sup>®</sup>	3	Top	2.7	0.7	-2.0	-74.1	20.0	19.7	-0.3	-1.5
Tectrol <sup>®</sup>	3	Middle	11.3	0.7	-10.6	-93.8	18.0	19.7	1.7	9.4
Tectrol <sup>®</sup>	3	Bottom	19.7	0.7	-19.0	-96.4	16.2	19.7	3.5	21.6
Tectrol <sup>®</sup>	6	Top	4.2	0.9	-3.3	-78.6	19.7	19.3	-0.4	-2.0
Tectrol <sup>®</sup>	6	Middle	11.7	0.9	-10.8	-92.3	18.0	19.4	1.4	7.8
Tectrol <sup>®</sup>	6	Bottom	21.5	0.6	-20.9	-97.2	15.8	19.7	3.9	24.7
Tectrol <sup>®</sup>	7	Top	5.6	0.8	-4.8	-85.7	19.5	19.5	0.0	0.0
Tectrol <sup>®</sup>	7	Middle	14.3	0.8	-13.5	-94.4	17.5	19.6	2.1	12.0
Tectrol <sup>®</sup>	7	Bottom	20.0	0.8	-19.2	-96.0	16.2	19.6	3.4	21.0
Tectrol <sup>®</sup>	9	Top	4.0	1.0	-3.0	-75.0	19.8	19.4	-0.4	-2.0
Tectrol <sup>®</sup>	9	Middle	11.1	0.8	-10.3	-92.8	18.1	19.4	1.3	7.2
Tectrol <sup>®</sup>	9	Bottom	25.0	0.8	-24.2	-96.8	15.4	19.5	4.1	26.6
Tectrol <sup>®</sup>	10	Top	4.6	0.7	-3.9	-84.8	19.8	19.9	0.1	0.5
Tectrol <sup>®</sup>	10	Middle	12.7	0.6	-12.1	-95.3	17.8	19.8	2.0	11.2
Tectrol <sup>®</sup>	10	Bottom	20.7	0.7	-20.0	-96.6	16.0	19.7	3.7	23.1
Tectrol <sup>®</sup>	14	Top	3.3	1.0	-2.3	-69.7	19.9	19.4	-0.5	-2.5
Tectrol <sup>®</sup>	14	Middle	12.4	1.0	-11.4	-91.9	17.9	19.3	1.4	7.8
Tectrol <sup>®</sup>	14	Bottom	25.0	1.1	-23.9	-95.6	15.0	19.2	4.2	28.0
Average			12.80	0.77			17.79	19.59		

## **Conclusions**

PEAKfresh<sup>®</sup> treated pallets of 'Albion' strawberries had a lower temperature during cross-country shipment than the Tectrol<sup>®</sup> treated pallets. Berries in the PEAKfresh<sup>®</sup> treated pallets became softer on average than berries in the Tectrol<sup>®</sup> treated pallets during cross-country shipment, and this is in agreement with previous research on the effect of elevated CO<sub>2</sub> on strawberry firmness during cold storage or cold shipment. There was some evidence to suggest that the effect of the treatments on firmness varied slightly from level to level within a pallet but these differences were not significant. There were no differences in color or weight loss of the berries as affected by pallet treatment, during cross-country shipment.

Other than measurable differences in firmness, based on this test, the Tectrol and PEAKfresh systems were comparable. However, decay was not assessed before or after shipment so no statement can be made on the effect of either system on decay development either during shipment or subsequent retail marketing.

## **Recommendations**

This study should be repeated. The same variety and number of pallets should be employed but all berries should be of the same variety and harvested from the same field. Since recent research indicates that there is little to no effect on berry color by either the Tectrol<sup>®</sup> system or strawberry pallet covers (Macnish et al., 2012), and since this experiment indicated little effect of location within a pallet on results, the experiment could be simplified to include less variables and samples. However, if repeated, decay should be quantified both and after shipment to allow statistical analysis of the effect of the Tectrol<sup>®</sup> system and PEAKfresh<sup>®</sup> strawberry pallet covers on strawberry quality and decay.

## **Concurrent Work**

USDA inspection of the fruit occurred concurrently with this study. A USDA inspector graded fruit from all pallets in Castroville, CA and the same inspector again graded the fruit at the NYC Produce Terminal Market in Hunts Point in the Bronx after final gas measurements had been made of the pallets. Based on the subjective ranges employed in USDA grading, it is very difficult to compare the strawberries subjected to the Tectrol<sup>®</sup> system to those overwrapped with PEAKfresh's strawberry pallet bags.

The conclusion of the inspector was that the Tectrol<sup>®</sup> treated berries, after shipment, failed to meet U.S. Grade No. 1 due to, apparently significant, decay problems with a few samples. Since grading involves defect or disease ranges, and since the raw data was not provided to the researchers on this project, it is impossible to estimate the exact percentage of decay developed by berries subjected to both pallet systems. Further, as the berries treated with the Tectrol<sup>®</sup> system were initially softer than those covered with PEAKfresh<sup>®</sup> bags, and as the berries treated with the Tectrol<sup>®</sup> system were from a different field than those overwrapped with PEAKfresh<sup>®</sup> bags, it is not possible to determine if the increase in decay was due to the use of the Tectrol<sup>®</sup> system or from inherent differences in the berries.

### **References**

- Larsen, M. and C. B. Watkins. 1995. Firmness and aroma composition of strawberries following short term high carbon dioxide treatments. *HortScience* 30:303-305.
- Macnish, A. J., M. S. Padda, F. Pupin, P. I. Tsouvaltzis, A. I. Deltsidis, C. A. Sims, J. K. Brecht and E. J. Mitcham. 2012. Comparison of pallet cover systems to maintain strawberry fruit quality during transport. *HortTechnology* 22(4):493-501.
- Plocharski, W. 1982. Strawberry – quality of fruits, their storage life and suitability for processing – Part III. Firmness and pectic substance changes of strawberries stored under normal and controlled atmosphere conditions. *Fruit Sci. Rpts.* 9:111-122.
- Smith, R. B. 1992. Controlled-atmosphere storage of redcoat strawberry fruit. *J. Amer. Soc. Hort. Sci.* 117:260-264.
- Smith, R. B. and L. J. Skog. 1992. Postharvest carbon dioxide treatment enhances firmness of several cultivars of strawberry. *HortScience* 27:420-421.
- Watkins, C. B., J. E. Manzano-Mendez, J. F. Nock, J. Z. Zhang and K. E. Maloney. 1999. Cultivar variation in response of strawberry fruit to high carbon dioxide treatments. *J. Sci. Food Agr.* 79:886-890.
- Zhang, J. J. and C. B. Watkins. 2005. Fruit quality, fermentation products, and activities of associated enzymes during elevated CO<sub>2</sub> treatment of strawberry fruit at high and low temperatures. *J. Amer. Soc. Hort. Sci.* 130(1):124-130.



## Addendum

# USDA Inspection Certificates

**9/20/12 - 9/24/12**

***Guide to USDA Inspection Certificates:***

Sweet Darling Brand = Tectrol treated strawberries

White Horse Brand = PEAKfresh treated strawberries

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USDA		U.S. DEPARTMENT OF AGRICULTURE AGRICULTURAL MARKETING SERVICE http://FPBInspections.ams.usda.gov		INSPECTION CERTIFICATE T-011-0329-00664	
				PAGE 1 of 2	
CARRIER or LOT ID: PO VERBAL GREG		APPLICANT: PEAKFRESH USA		REQUESTED:	9/20/2012 1:00 PM
LOADING STATUS: UNLOADED				STARTED:	9/20/2012 4:16 PM
STATED BY: APPLICANT		SHIPPER: SWEET DARLING SALES, INC.		COMPLETED:	9/20/2012 7:35 PM
ADDITIONAL ID: PRIOR TO LOADING		APTOS (SE), CA		PASSWORD FOR ONLINE ACCESS	
CARRIER TYPE: NA		MARKET OFFICE: NEW YORK, NY		53ZRR6Y7KKCMXUD5	
REFRIG UNIT: NA	DOORS: NA	INSP SITE: SWEET DARLING COOLER;11709 CASTRO ST. CASTROVILLE, CA		ESTIMATED FEE:	\$3742.19
REMARKS: TIME AT START OF INSPECTION IS ACTUALLY 4:16 P.M. EASTERN DAYLIGHT TIME TO REFLECT DUTY STATION TIME IN NEW YORK CITY TERMINAL MARKET, NEW YORK. ACTUAL TIME AT START OF INSPECTION WAS 1:16 P.M. PACIFIC TIME IN CASTROVILLE, CALIFORNIA AT INSPECTION SITE.					
<b>LOT A (QAC) - STRAWBERRIES</b>					
TEMP:	31° to 32°F	INSP CT:	YES	NUMBER OF CONTAINERS:	756 MASTER CARTON(S)
MARKINGS:		BRAND: SWEET DARLING VARIETY: ALBION MARKINGS: PLASTIC HINGED CONTAINERS LABELED CALIFORNIA STRAWBERRIES GROWER PACKER SHIPPER LARSE FARMS WATSONVILLE, CA PRODUCE OF USA NET WT. 16 OZ. (1LB) MASTER CARTONS STICKERED WHITE STICKER 70509120 8-16 OZ CLAMSHELLS			
PLI: NONE		OTHER ID: P6-1, P6-2, P7-3, P10-14, P7-4, P3-5, P3-6, P2-7, P2-8, P9-9, P9-10, P14-11, P14-12, P10-13			
INJURY	DAM	SER DAM	V.S. DAM	OFFSIZE/DEFECTS	
NA	0	0	NA	QUALITY DEFECTS (0 to 6%)(UNDEVELOPED)	
NA	1	0	NA	BRUISING (0 to 10%)	
NA	<0.5	<0.5	NA	DECAY (0 to 6%)	
NA	1	0	NA	CHECKSUM	
GRADE:	MEETS U.S. NO. 1.				
LOT DESC:	DIAMETER: 1-1/4 TO 2-1/4 INCHES BRIGHTNESS: BRIGHT COLOR OF CALYX: LIGHT GREEN FIRMNESS: GENERALLY FIRM STAGES OF DECAY: MODERATE TEMPERATURES(4): 32°F (TOP LAYER CARTONS ON PALLETS), 31°F (TOP LAYER CARTONS ON PALLETS), 32°F (TOP LAYER CARTONS ON PALLETS), 32°F (BOTTOM LAYER CARTONS ON PALLETS)				
I, the undersigned, a duly authorized inspector of the United States Department of Agriculture, do hereby certify that at the request of the applicant and on the date indicated, samples of the herein described product were inspected and the quality and/or condition as shown by said samples were as herein stated.					
Warning: Any person who knowingly shall falsely make, issue, alter, forge, or counterfeit this certificate or participate in any such actions, is subject to a fine of not more than \$1,000 or imprisonment for not more than one year, or both.			Signature: 0329 - CHOFFEL, DORENE		Date:
FORM FV-E300 (1.0.13.1)					9/20/2012

USDA		U.S. DEPARTMENT OF AGRICULTURE AGRICULTURAL MARKETING SERVICE http://FPBInspections.ams.usda.gov		INSPECTION CERTIFICATE T-011-0329-00664	
				PAGE 2 of 2	
CARRIER or LOT ID: PO		VERBAL GREG		APPLICANT: PEAKFRESH USA	
LOADING STATUS: UNLOADED				REQUESTED: 9/20/2012 1:00 PM	
STATED BY: APPLICANT		SHIPPER: SWEET DARLING SALES, INC.		STARTED: 9/20/2012 4:16 PM	
ADDITIONAL ID: PRIOR TO LOADING		APTOS (SE), CA		COMPLETED: 9/20/2012 7:35 PM	
CARRIER TYPE: NA		MARKET OFFICE: NEW YORK, NY		PASSWORD FOR ONLINE ACCESS	
REFRIG UNIT: NA		DOORS: NA		53ZRR6Y7KKCMXUD5	
		INSP SITE: SWEET DARLING COOLER;11709 CASTRO ST. CASTROVILLE, CA		ESTIMATED FEE: !	
REMARKS: TIME AT START OF INSPECTION IS ACTUALLY 4:16 P.M. EASTERN DAYLIGHT TIME TO REFLECT DUTY STATION TIME IN NEW YORK CITY TERMINAL MARKET, NEW YORK. ACTUAL TIME AT START OF INSPECTION WAS 1:16 P.M. PACIFIC TIME IN CASTROVILLE, CALIFORNIA AT INSPECTION SITE.					
<b>LOT B (QAC) - STRAWBERRIES</b>					
TEMP: 31° to 32°F		INSP CT: YES		NUMBER OF CONTAINERS: 756 MASTER CARTON(S)	
MARKINGS:		ORIGIN: CA			
BRAND: WHITE HORSE VARIETY: ALBION MARKINGS: PLASTIC HINGED CONTAINERS LABELED CALIFORNIA STRAWBERRIES GROWER PACKER SHIPPER LARSE FARMS WATSONVILLE, CA PRODUCE OF USA NET WT. 16 OZ. (1LB) MASTER CARTONS STICKERED WHITE STICKER 819120 8-16 OZ CLAMSHELLS					
PLI: NONE			OTHER ID: P5-1, P5-2, P4-3, P4-4, P8-5, P8-6, P1-7*, P1-8, P13-9, P13-10, P12-11, P12-12, P11-13, P11-14		
INJURY	DAM	SER DAM	V.S. DAM	OFFSIZE/DEFECTS	
NA	0	0	NA	QUALITY DEFECTS	
NA	2	0	NA	BRUISING (0 to 15%)	
NA	0	0	NA	DECAY	
NA	2	0	NA	CHECKSUM	
GRADE:		MEETS U.S. NO. 1.			
LOT DESC:		DIAMETER: 1-1/4 TO 2 INCHES BRIGHTNESS: BRIGHT COLOR OF CALYX: LIGHT GREEN FIRMNESS: FIRM TEMPERATURES(3): 32°F (TOP LAYER CARTONS ON PALLETS), 31°F (BOTTOM LAYER CARTONS ON PALLETS), 32°F (CENTER CARTONS IN PALLET)			
I, the undersigned, a duly authorized inspector of the United States Department of Agriculture, do hereby certify that at the request of the applicant and on the date indicated, samples of the herein described product were inspected and the quality and/or condition as shown by said samples were as herein stated.					
Warning: Any person who knowingly shall falsely make, issue, alter, forge, or counterfeit this certificate or participate in any such actions, is subject to a fine of not more than \$1,000 or imprisonment for not more than one year, or both.			Signature: 0329 - CHOFFEL, DORENE		Date: 9/20/2012
FORM FV-E300 (1.0.13.1)					

USDA		U.S. DEPARTMENT OF AGRICULTURE AGRICULTURAL MARKETING SERVICE http://FPBInspections.ams.usda.gov		INSPECTION CERTIFICATE T-011-0329-00667	
				PAGE 1 of 2	
CARRIER or LOT ID: 4HU8035 CA		APPLICANT: PEAKFRESH USA		REQUESTED: 9/24/2012 7:15 AM	
LOADING STATUS: LOADED		LAKE FOREST, CA		STARTED: 9/24/2012 11:25 AM	
STATED BY: INSPECTOR		SHIPPER: SWEET DARLING SALES, INC.		COMPLETED: 9/24/2012 1:43 PM	
ADDITIONAL ID: PO# VERBAL GREG/289407		APTOS (SE), CA		PASSWORD FOR ONLINE ACCESS	
CARRIER TYPE: MECHANICAL REFRIGERATED		MARKET OFFICE: NEW YORK, NY		JWGSLHX4E9JWGS	
REFRIG UNIT: ON		DOORS: CLOSED		ESTIMATED FEE:	
		INSP SITE: E. ARMATA, INC. WAREHOUSE C-389 BRONX, NEW YORK			
REMARKS: CHECK NO: 8200 CHECK AMT: INSPECTION ORIGINALLY STARTED AT 8:24 A.M. EASTERN DAYLIGHT SAVINGS TIME. NEW CERTIFICATE HAD TO BE STARTED DUE TO A CORRUPTED CERTIFICATE. PRODUCT IN BOTH LOTS PREVIOUSLY INSPECTED ON THURSDAY, SEPTEMBER 20, 2012 IN CASTROVILLE, CA AND REPORTED ON FEDERAL CERTIFICATE T-011-0329-00664. CREDIT CARD AUTHORIZATION NUMBER-# 25-837-FSO.					
<b>LOT A (QAC) - STRAWBERRIES</b>					
TEMP: 36° to 37°F		INSP CT: YES		NUMBER OF CONTAINERS: 758 MASTER CARTON(S)	
MARKINGS:		ORIGIN: CA			
		BRAND: SWEET DARLING VARIETY: ALBION MARKINGS: PLASTIC HINGED CONTAINERS LABELED CALIFORNIA STRAWBERRIES GROWER PACKER SHIPPER LARGE FARMS WATSONVILLE, CA PRODUCE OF USA CAT 1 NET WT. 16 OZ. (1LB) MASTER CARTONS STICKERED WHITE STICKER 70509120 8-16. OZ CLAMSHELLS			
PLI: NONE		OTHER ID: P6-1, P6-2, P7-3, P7-4, P3-5, P3-6, P2-7, P2-8, P9-9, P9-10, P14-11, P14-12, P10-13, P10-14			
INJURY	DAM	SER DAM	V.S. DAM	OFFSIZE/DEFECTS	
NA	0	0	NA	QUALITY DEFECTS (0 to 6%)(UNDEVELOPED)	
NA	4	0	NA	BRUISING (0 to 11%)	
NA	<1	<1	NA	DECAY (0 to 11%)	
NA	5	1	NA	CHECKSUM	
GRADE:		FAILS TO GRADE U.S. NO. 1 ACCOUNT CONDITION, (DECAY), IN FEW SAMPLES.			
LOT DESC:		DIAMETER: 1-1/4 TO 2-1/4 INCHES BRIGHTNESS: GENERALLY BRIGHT COLOR OF CALYX: LIGHT GREEN FIRMNESS: GENERALLY FIRM STAGES OF DECAY: ADVANCED TEMPERATURES(3): 36°F, 37°F, 36°F			
I, the undersigned, a duly authorized inspector of the United States Department of Agriculture, do hereby certify that at the request of the applicant and on the date indicated, samples of the herein described product were inspected and the quality and/or condition as shown by said samples were as herein stated.					
Warning: Any person who knowingly shall falsely make, issue, alter, forge, or counterfeit this certificate or participate in any such actions, is subject to a fine of not more than \$1,000 or imprisonment for not more than one year, or both. FORM FV-E300 (1.0.13.1)			Signature: 0329 - CHOFFEL, DORENE <i>Dorene M Choffel</i>		Date: 9/24/2012

		U.S. DEPARTMENT OF AGRICULTURE AGRICULTURAL MARKETING SERVICE http://FPBInspections.ams.usda.gov		INSPECTION CERTIFICATE T-011-0329-00667	
				PAGE 2 of 2	
CARRIER or LOT ID: 4HU8035 CA		APPLICANT: PEAKFRESH USA		REQUESTED: 9/24/2012 7:15 AM	
LOADING STATUS: LOADED		LAKE FOREST, CA		STARTED: 9/24/2012 11:25 AM	
STATED BY: INSPECTOR		SHIPPER: SWEET DARLING SALES, INC.		COMPLETED: 9/24/2012 1:43 PM	
ADDITIONAL ID: PO# VERBAL GREG/289407		APTOS (SE), CA		PASSWORD FOR ONLINE ACCESS	
CARRIER TYPE: MECHANICAL REFRIGERATED		MARKET OFFICE: NEW YORK, NY		JWGSLLHXS4E9JWGS	
REFRIG UNIT: ON		DOORS: CLOSED		ESTIMATED FEE:	
		INSP SITE: E. ARMATA, INC. WAREHOUSE C-369 BRONX, NEW YORK			
REMARKS: CHECK NO: 8200 CHECK AMT: INSPECTION ORIGINALLY STARTED AT 8:24 A.M. EASTERN DAYLIGHT SAVINGS TIME. NEW CERTIFICATE HAD TO BE STARTED DUE TO A CORRUPTED CERTIFICATE. PRODUCT IN BOTH LOTS PREVIOUSLY INSPECTED ON THURSDAY, SEPTEMBER 20, 2012 IN CASTROVILLE, CA AND REPORTED ON FEDERAL CERTIFICATE T-011-0329-00664. CREDIT CARD AUTHORIZATION NUMBER-# 25-837-FSO.					
<b>LOT B (QAC) - STRAWBERRIES</b>					
TEMP: 38° to 37°F		INSP CT: YES		NUMBER OF CONTAINERS: 756 MASTER CARTON(S)	
ORIGIN: CA					
MARKINGS: BRAND: WHITE HORSE VARIETY: ALBION MARKINGS: PLASTIC HINGED CONTAINERS LABELED CALIFORNIA STRAWBERRIES GROWER PACKER SHIPPER LARSE FARMS WATSONVILLE, CA PRODUCE OF USA CAT 1 NET WT. 16 OZ. (1LB) MASTER CARTONS STICKERED WHITE STICKER 819120 8-16. 0Z					
PLI: NONE			OTHER ID: P5-1, P5-2, P4-3, P8-5, P8-6, P1-8, P1-7, P13-9, P13-10, P12-11, P12-12, P11-13, P11-14		
<b>INJURY DAM SER DAM V.S. DAM OFFSIZE/DEFECTS</b>					
INJURY	DAM	SER DAM	V.S. DAM	OFFSIZE/DEFECTS	
NA	0	0	NA	QUALITY DEFECTS	
NA	5	1	NA	BRUISING (0 to 14%)	
NA	<1	<1	NA	DECAY (0 to 6%)	
NA	6	2	NA	CHECKSUM	
GRADE: MEETS U.S. NO. 1.					
LOT DESC: DIAMETER: 1-1/4 TO 2 INCHES BRIGHTNESS: GENERALLY BRIGHT COLOR OF CALYX: LIGHT GREEN FIRMNESS: GENERALLY FIRM STAGES OF DECAY: APPROX HALF ADVANCED, APPROX HALF EARLY TEMPERATURES(3): 38°F, 37°F, 37°F					
I, the undersigned, a duly authorized inspector of the United States Department of Agriculture, do hereby certify that at the request of the applicant and on the date indicated, samples of the herein described product were inspected and the quality and/or condition as shown by said samples were as herein stated.					
Warning: Any person who knowingly shall falsely make, issue, alter, forge, or counterfeit this certificate or participate in any such actions, is subject to a fine of not more than \$1,000 or imprisonment for not more than one year, or both.				Signature: 0329 - CHOFFEL, DORENE	
FORM FV-E300 (1.0.13.1)				Date: 9/24/2012	



## Advantages of PEAKfresh®

As a sponsor of this third-party study, it is PEAKfresh®'s objective to demonstrate that our system for prolonging shelf-life and ensuring that fruits and vegetables arrive to market safe and fresh, is equally efficacious as the competing system that employs CO2 gas.

Further, we believe our system has advantages vs. the competing CO2 system that growers, shippers, and receivers of fresh produce should be aware of:

- **Non-sealed, gas-free system provides savings - no special equipment required for installation, fewer employees and less time for installation.**
- **Pallet cover design is superior to sealed-system alternatives because it wicks moisture to the floor when product is exposed to lapses in the “cold chain.”**
- **Responsible and recyclable Unsealed Modified Atmosphere Packaging System to prolong shelf-life.**

*Please contact Greg Ganzerla, CEO, PEAKfresh® USA, with any questions or information requests regarding the study.*

**PEAKfresh®**  
PRODUCE BAGS

PEAKfreshUSA  
26786 Vista Terrace  
Lake Forest, CA 92630

877-537-3748 • [www.peakfreshusa.com](http://www.peakfreshusa.com)

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**PEAK** *fresh*<sup>®</sup>

**"The Best Pallet Covers Without CO2"**

**Strawberry Test Report**

**September 2012**

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