Simulated In-Transit Vibration Damage

To Fresh Market Raspberries

by

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Introduction

In-transit vibration damage causes millions of dollars damage to fresh produce annually. A possible way to reduce damage is to alter transport vehicle suspensions. The initial step in implementing this solution is to determine which vibration frequencies are causing the damage. To accomplish this we exposed fruits to several vibration frequencies in our laboratory.

One commodity we worked with was raspberries, which are one of the most delicate, costly, and perishable fruits. In-transit vibration causes abrasions and bruises, which affect color of berries and encourage mold and decay. Reduction of this damage would result in extended shelf life and enhanced marketability.

Objective

The objective of this study was to determine the influence of position in a stack of boxes and the most damaging vibration frequency. Previous research has shown that, as stack height increases, damage increases; and most product damage occurs within a very narrow critical frequency band.

Methodology

Raspberries were purchased in standard berry flats. Each of these flats contained 12½ pint baskets of berries. Three vibration frequency ranges were used for this study. They were 6.5-9, 9-11.5, and 11.5-14 hertz, respectively. These ranges were chosen because previous research showed critical frequencies of other types of fruit to be in the 6.5-9 and 9-11.5 hertz ranges and preliminary testing showed maximum movement of stacked flats of raspberries in the 6.5-9 and 9-11.5 ranges. The 11.5-14 hertz range was used to see if damage would decrease at a higher frequency.

Flats of raspberries were stacked 20 high on a pallet. Sample baskets were placed in the top, middle, and bottom flats. They were vibrated for ½ hour at ½ g. Accelerometers mounted on the pallet and the top of the stack monitored force levels. This process was repeated 3 times at each frequency range, using fresh berries each time.

After each vibration treatment the baskets of sample berries were removed from the stack and rated for bruise and abrasion damage. The ratings were: "No Damage," berries with less than 10 percent of surface affected; "Moderate Damage," berries with up to 50 percent of surface affected; and "Severe Damage," unsalable berries with more than 50 percent of surface affected.

Next, the berries were evaluated with a colorimeter. This device evaluates color through three measurements, "L" which represents lightness or darkness, "a" which represents redness or greenness, and "b" which represents yellowness or blueness.

Results and Discussion

The analysis of variance was used, first to determine if there were significant differences in damage between treated and non-treated product. Next, data from treated product were analyzed to assess effect of stack position and treatment frequency.

The percentage of sample berries considered unsalable, or showing severe bruises and abrasions, after treatment was significantly greater ($\alpha \leq 0.05$) in the 6.5-9 and 9-11.5 hertz frequency ranges and at the top stack position. Within the 9-11.5 hertz range, the top stack position received more than twice as much damage as the bottom, and more than three and one half times as much as the middle.

Color analysis for treated product by stack position showed that mean "L" values declined as stack height increased, indicating darker berries toward the top stack position. The "L" value at the top stack position was significantly lower ($\alpha \leq 0.05$) than at the bottom stack position. Mean "a" values increased, indicating redder berries, as stack height increased. The "a" value at the top stack position was significantly greater ($\alpha \leq 0.05$) than the "a" values at both the middle and bottom positions. Mean "b" values were roughly constant across the three stack positions.

Color analysis by frequency showed lower mean "L" values and higher mean "a" and "b" values for the 6.5-9 and 9-11.5 hertz ranges. However, only "a" values showed a statistically significant difference ($\alpha \leq 0.05$) between the 9-11.5 and 11.5-14 hertz ranges. Mean "a" values for the 9-11.5 range were higher indicating redder berries than the 11.5-14 hertz range.

Conclusions

Most damage occurred in top boxes. Middle boxes appeared to show somewhat less damage than bottom boxes, however these differences were not statistically significant. The 6.5-9 and 9.5-11 hertz ranges were the most damaging.

These results indicate significant reduction of in-transit damage to fresh raspberries may be accomplished by altering transport vehicle suspensions to damp out frequencies below 11.5 hertz.