Forced Air Cooling of Strawberries in Clamshell Baskets

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Background

Strawberries are increasingly marketed in one pound-capacity, lidded containers (commonly called clamshell baskets). These containers have a reputation of being slow to cool compared to other containers. Manufacturers have responded to this by developing containers with new air vent designs. The purpose of this test was to compare cooling time for a range of commercial and prototype clamshell baskets. We did not compare other other basket performance characterisitcs such as basket strength and its effect on berry moisture loss, decay development and mechanical damage to the fruit.

Procedure

We packed all containers with Selva strawberries from the same field. The fruit were uniform sized and had a minimum shoulder diameter of about 1.25 inches. All baskets were placed in the same style 16" x 20" tray. It had recessed sides along its short dimension and four vents near the bottom edge of the side wall for air flow. The trays had no vents on the bottom for verticle air flow. Baskets from five manufacturers were tested.

Two trays of each clamshell basket style were transported to UC Davis and cooled in a laboratory forced air cooler. Trays were placed two across in a layer and oriented so air flowed parallel to the 20" tray dimension and through both trays, to simulate the air flow path in a commercial cooler. Five layers of test baskets, each of a different basket style, plus a non test layer on top were placed on the laboratory cooler. Pressure drop across the double stack of boxes was 0.35 - 0.38 inch of water column.

Fruit temperature was monitored with thermocouples (± 0.2°C accuracy) placed in the center of berries near the shoulder. Monitored berries were in the center of the top berry layer in each of four baskets for each basket type. Two baskets were near the tray edge where cold air entered and two were near the tray edge where air exited the trays. Cooling times were based on the average temperature of the four sensors. Berries were considered cool (based on 7/8 ths cooling time) when their temperature dropped to average cooling air temperature plus 1/8 th of the difference between their initial temperature and average cooling air temperature. The average cooling air temperature was its average temperature between one and two hours after air flow began. The test was repeated three times, each with a different order of basket types on the cooler.

Results

Two basket designs had 7/8ths cooling times of slightly less than 70 minutes, Table 1. A second group cooled in about 90 minutes and the slowest basket cooled in over 110 min. Variability in cooling times may have been caused by berry size differences, placement of thermocouples, and relative position of trays in each test. The least significant difference of this test was 16 min. This means that we cannot detect a statistically significant difference between two average cooling times unless they are at least 16 min. different.

Table 1. Cooling time for five types of clamshell berry baskets.

Clamshell basket Type	Average 7/8ths cooling time (min.)	Range of cooling times (min.)	Statistical groupings[1]
A	67	61-72	a
B	68	63-70	a
C	89	83-93	b
D	93	87-104	b
E	113	107-120	c

[1] baskets with the same letter do not have statistically different cooling times based on Fischer's PLSD, 5% level

Table 2. Vent area for five types of clamshell berry baskets.

Clamshell area (%)	Side vent area (%)	End vent vent area (%)	top+Bottom
A	35	31	vents covered[1]
B	13	10	vents covered
C	7	6	vents covered
D	5	4	12
E	none	none	20

[1] Bottom vents were covered by the tray bottom or top vents were covered by the tray above.

Cooling times appear to be related to the per cent vent area on the sides and end of the baskets, Table 2. Fastest cooling is achieved by the clamshell baskets with 13% or more side vent area. There appears to be no advantage to having a vent area more than 13%. In fact the optimum vent area may be some where between 7% and 13%. The middle grouping of baskets had 5% to 7% side vent area. In spite of the large top and bottom vent area of basket E and specially designed standoffs to prevent the vents from being covered by tray surfaces, it cooled slower than the others tested. Apparently the lack of side venting restricted air flow to the berries.

Conclusions

Fastest cooling of strawberries is obtained in clamshell baskets with13% or more side area venting. It is possible that similar cooling times could be obtained with vent area less than 13% but more than 7%.