Effects of basket design on cooling and holding strawberries

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Fig. 1. Tests compared baskets of open-mesh extruded plastic (left) and solid-sided moulded plastic (right).

Most fresh California strawberries are packed in open-mesh, rigid plastic baskets. Whereas these baskets allow good air circulation, they can cause fruit injury. Recently, there has been renewed interest in using various solid-sided baskets to reduce fruit injury. Widespread acceptance has been hindered by concern that solid baskets might slow the cooling rate and, if made of solid plastic, baskets might increase moisture condensation or "sweating" on the inner basket surface, thereby causing fruit rot.

The tests reported here were specifically designed to evaluate cooling rate and condensation effects when strawberries are held in open baskets inside shipping crates. No

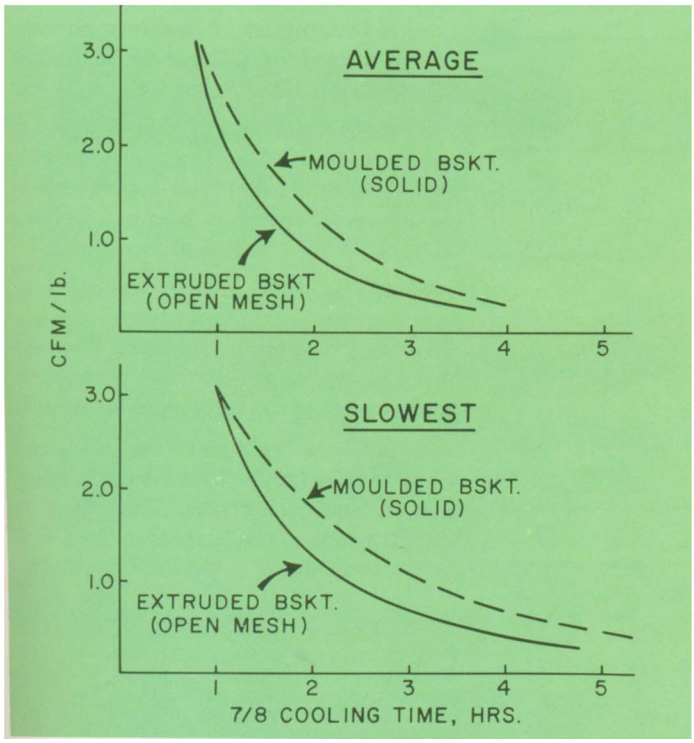

Fig. 2. Air volume requirements to cool strawberries in different baskets. Air flow is shown in cubic feet per minute per pound of fruit.

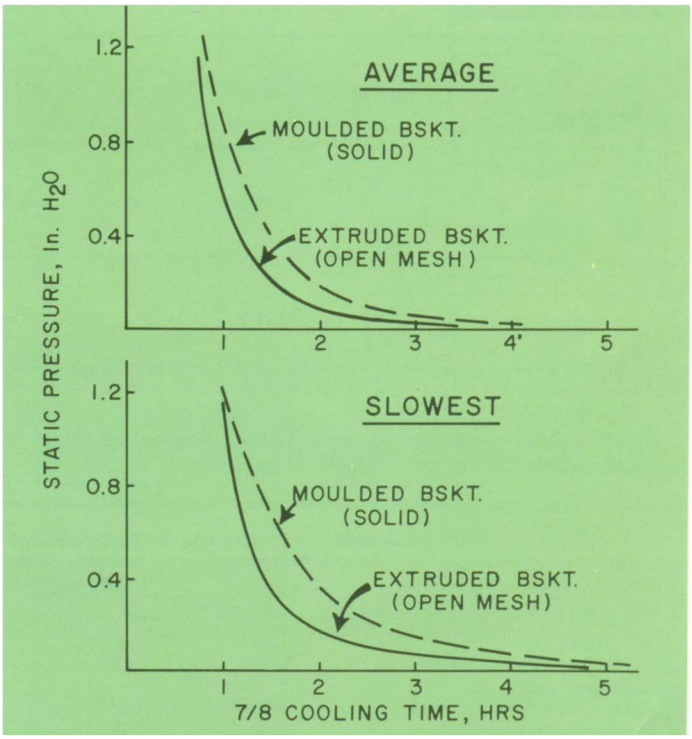

Fig. 3. Static pressure requirement to cool strawberries in different baskets. Static pressure is shown as inches of water (w.g. = water gauge).

covers or caps were used. Open-mesh extruded plastic baskets were compared with solid-sided moulded baskets (fig. 1).

'Heidi' variety strawberries for these tests were harvested in the Watsonville area in mid-October. To test condensation effects, four commercial pickers each filled four crates of each of the two basket types with strawberries. Immediately after harvest the fruit was transported to Davis (a 3-hour delay) and placed on test. One crate from each picker and each basket style was placed in each of four treatments—a total of 32 crates.

The 48-hour treatments applied to the fruit were (1) constant 68°F, (2) constant 41°F, (3) 24 hours at 41°F then 24 hours at 68°F, and (4) 12 hours alternately at 41°, 68°, 41°, and 68°F. The alternating temperatures caused water condensation. After the 48-hour treatment, all fruit was graded by two evaluators, each rating half of all crates. Fruit was scored as decayed, soft, or sound.

Although there was greater condensation in the solid baskets, there was no evidence that condensation had any effect on incidence of decay (table 1). Differences in decay levels were generally insignificant: basket design had no significant effect on fruit quality.

Cooling

Fruit for the cooling tests was commercially harvested and packed in 12 crates of each basket style (24 crates in all). Upon arrival in Davis, fruit was promptly cooled and held for later testing. Forced-air cooling was used because it is now almost universally used for cooling strawberries in California.

Nine crates were placed three high and three wide, so that air would flow across the three-crate width in a specially designed cooling tunnel. Top, bottom, and sides of the tunnel were insulated to simulate a "pallet core." The middle layer was thus cooled under conditions that previous tests have shown duplicate those in the center of a fully-loaded pallet of fruit.

Thermocouples were placed in the middle layer at 10 positions along the course of the air flow—inserted into the centers of inch-diameter berries situated in the centers of the baskets. Fruits were warmed to uniform temperature before cooling. Air flow was regulated by adjusting orifices and static pressure. Cooling curves were developed for the two basket styles by measurement at four static pressure levels across the fruit. After two warming and cooling tests, center crates were replaced to avoid previously shriveled fruit affecting cooling results.

Cooling was slower in the solid-sided basket, in spite of increased air volume (fig. 2) and increased static pressure (fig. 3). The effect of basket design on cooling rate is similar whether calculated from average or slowest cooling data. The results of these cooling differences on air flow requirements for 7/8 cooling are presented in table 2. Seven-eighths cooling is achieved when the product has cooled 7/8 of the difference between initial temperature and the temperature of the cooling medium. For example, strawberries that had been 75° would be 7/8 cool in 35°F air at 40°F, or [(75 − 35) ÷ 8] + 35.

TABLE 1. Effect of Holding Treatment and Basket Design on Strawberry Deterioration

TREATMENT TEMP. °F — 48 HR. TEST	SOUND FRUIT		SOFT FRUIT (PER CENT)		DECAY	
	MESH	SOLID	MESH	SOLID	MESH	SOLID
68 / 41	94.8 d	93.9 d	4.4 abc	4.1 abc	0.8 a	2.0 a
68 / 41	75.9 bc	81.6 c	10.2 e	9.1 de	13.9 bc	9.3 ab
68 / 41	70.3 b	73.8 bc	7.3 cde	5.8 bcd	22.4 c	20.4 c
68 / 41	43.8 a	52.7 a	1.0 a	3.4 ab	55.2 e	44.0 d

0 12 24 36 48 HOURS

*Figures within any grading category followed by same letter are not significantly different at the 0.05 level, as measured by Duncan's Multiple Range Test.

TABLE 2. Slowest 7/8 Cooling Requirements—Strawberries

Baskets	7/8 cooling time (hours)			
open mesh	**1.5**	**2.0**	**3.0**	**4.0**
air volume (cfm/lb)*	1.9	1.3	0.7	0.4
static pressure (in w.g.)†	(0.4)	(0.16)	(0.07)	(0.02)
solid sided				
air volume (cfm/lb)	2.3	1.8	1.1	0.6
static pressure (in w.g.)	(0.7)	(0.4)	(0.14)	(0.05)

*Cubic feet of air per minute per pound of fruit.
†Static pressure requirement is presented as inches of water (w.g. = water gauge).

Conclusions

In comparing the rigid open-mesh basket and the solid-sided moulded plastic basket, within the limits of these tests, the following points can be made:

- Differences in moisture condensation, caused by differences in basket design, do not affect incidence of fruit rot.
- Forced-air cooling is slightly slower under similar air-flow characteristics with the solid-sided basket than with the open-mesh basket, and must be accounted for in establishing a cooling procedure.
- The difference in cooling rate between the two basket styles suggests that corner venting, situated to avoid berry injury, might improve the cooling performance of the solid moulded basket.
- These tests were limited to the study of open-topped baskets under simulated transit conditions. The effect of applying caps to the baskets in the distribution market was not studied.

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