tion of m+ calves and their subsequent performance compared favorably with ++ calves for conception rate, calving ease, and viability.

Conclusions

The results presented here indicate about a 10% advantage (a statistically significant result) for the m+ market calf in pounds of trimmed retail cuts per day of age, with little or no reduction in carcass quality grade. Furthermore, no undesirable side effects occurred in the production or performance of these calves. This study has also demonstrated the feasibility of producing m+ market animals by mating mm bulls to ++ cows, using artificial insemination.

The University of California, Davis, has mm breeding bulls that can supply semen for cooperators, cattlemen or dairymen interested in further testing the usefulness of m+ beef or beef x dairy market calves.

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TABLE 2. EXPERIMENT 2
PERFORMANCE OF m+ MARKET CALVES PRODUCED BY CROSSING AN mm CHAROLAIS SIRE WITH COWS OF ANGUS, HEREFORD AND SHORTHORN BREEDING

Number in group	10
Days on feed	155
lb. TDN/lb gain	4.54
Slaughter age	387
Hot carcass weight (lb)	655
Dressing per cent	64.7
Rib eye area (sq. in.)	14.30
Fat thickness (in.)	.41
Cutability (percentage)*	52.0
Trimmed retail cuts/day of age (lb)	.886
Quality grade†	9.7
Marbling score‡	10.4

* Calculated according to the American Meat Science Association formula.
† 8 = average good; 9 = high good; 10 = low choice; . . . ; 13 = low prime; etc.
‡ 8 = slight; 9 = slight +; 10 = small –; . . . ; 13 = modest –; etc.

TABLE 3. PERFORMANCE OF m+ MARKET CALVES OF ANGUS × HOLSTEIN BREEDING, EXPERIMENT 3

Sex of calf	BULL	STEER	HEIFER
Days on feed	168	228	118
lb TDN/lb gain	4.60	5.02	5.70
Slaughter age	364	382	294
Hot Carcass weight (lb)	791	674	600
Dressing percent	66.2	64.5	65.9
Rib eye area (sq. in.)	15.6	14.0	12.3
Fat thickness (in.)	.3	.3	.4
Cutability (in percentage)*	52.18	52.77	50.93
Trimmed retail cuts/ day of age (lb)	1.13	.93	1.04
Quality grade†	9	11	9
Marbling score‡	8	14	9

* Calculated according to the Amerian Meat Science Association formula.
† 8 = average good; 9 = high good; 10 = low choice; . . . ; 13 = low prime; etc.
‡ 8 = slight; 9 = slight +; 10 = small –; . . . ; 13 = modest –; etc.

RAPID, UNIFORM WARMING OF CANNERY PEARS

R. A. PARSONS · E. C. MAXIE · F. G. MITCHELL · GENE MAYER

Pears in a simulated bin were warmed for ripening from 30° to 68°F in 15 and 25 minutes with 110°F air forced through the bin with air flow rates of 2 and 1 cubic ft per minute per pound of fruit, respectively. Pears held for up to two hours in the warm, rapid air flow were not adversely affected. Pears ripened to processing firmness in three to four days when warmed to 68°F in four hours or less. Fruit delayed in warming from one to seven and one-half days was delayed in ripening in almost direct relation to the time required to reach 68°F. Slow warming resulted in uneven ripening with soft and hard fruit in the same bin. The concept of a warming tunnel to attain uniform ripening and allow a processor to precisely program a canning schedule is suggested.

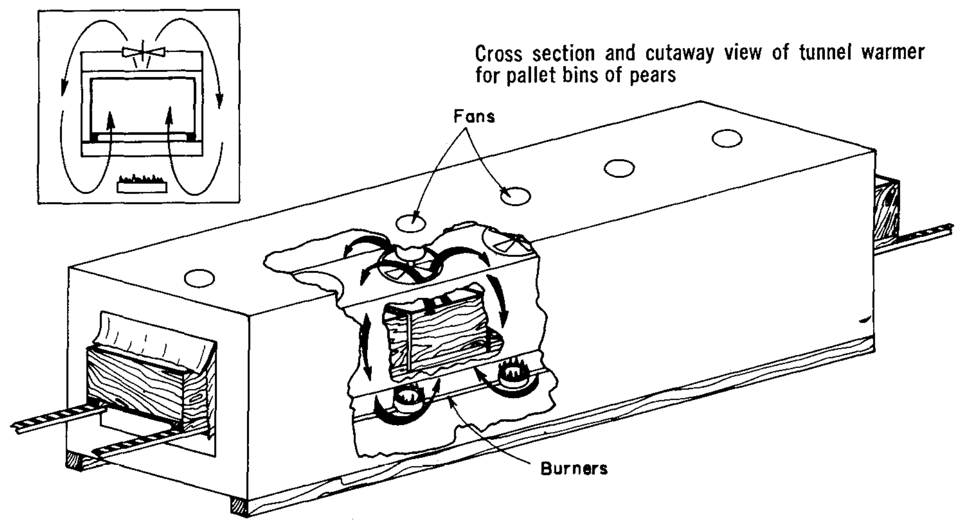
Bartlett pears stored and subsequently ripened in bins often show extreme variation in degree of ripeness at time of processing, with both hard and mushy fruit within the same bin. Unless care is taken to insure prompt, uniform warming, the time required to attain the ideal ripening temperature of 60°F may vary by as much as five to seven days between the most and least accessible fruit within a bin. This study developed a method for rapid and uniform warming of Bartlett pears and compared its effect with that of delayed warming on rate of ripening and fruit quality.

A 24-inch-deep box lined on the sides with foam padding and with approximate inside dimensions about 13 inches square was used to simulate a vertical core of fruit in a pallet bin. The bottom was vented like a bin with two ½-inch wide slots across the bottom.

The box was filled with about 95 lb of pears and placed on a fan chamber to draw (or force) air through it. Temperatures were recorded at the surface, core, and approximately ⅜ inch beneath the surface of four 3-inch diameter pears located at the top and bottom of the test bin. Pears at 30°F were placed in the bin core and the unit was placed in a 110°F room with the fan operating to draw warm air through the test bin. When the average temperature of the downstream fruit reached 68°F, the fan was stopped and the test chamber was moved to a 68°F room, where the fruit temperature was allowed to equalize. This testing procedure simulated the concept of a tunnel bin warmer that would convey bins through a heating chamber, forcing 110°F air vertically through the bin to rapidly warm the fruit (see sketch), and deliver the bins to a 68°F ripening room.

When an air flow of 2 cubic ft per minute per pound of fruit (cfm/lb) was used, pears were warmed to an average 68°F in 15 minutes. The surface temperatures, before removing from the warm room, ranged from 79° to 84°F and core temperatures from 44° to 51°F. Internal fruit temperatures equalized to 68°F ± 3°F in 30 minutes. A pressure of 3.6 inches (water gauge) was needed to force air at this rate through the bin. At 1.0 cfm/lb and an air pressure of 0.8 inches w.g., the average fruit warmed to 68°F in 25 minutes.

Fruits that were warmed to an average of 68°F in 15 minutes ripened uniformly to excellent quality in four days (graph 1). Lots held in the warmer for longer



Cross section and cutaway view of tunnel warmer for pallet bins of pears periods, and thus attaining much higher average and core temperatures, were not adversely affected. Ripening was slightly delayed where the core temperature reached 110°F (after two hours in the bin warmer), but the fruit reached full ripeness at the same time as the other lots. It should be emphasized that the higher temperatures were tested as a precaution against mishaps in commercial practice. The possible uneven ripening that could result from slow and uneven cooling following such high temperatures was not studied.

Warming for 15 minutes to an average temperature of 68°F was adequate. Typical standard deviation for firmness indicated that variability in lots was narrow on the first and second day following the warming, widened on the third day, then narrowed appreciably on the fourth and final day. At canning ripeness, the range between maximum and minimum firmnesses between fruits in a lot was less than 2½ lb.

To test the effect of delayed warming, samples of pears were warmed to 68°F in one hour, in four hours, and progressively moved from 33° to 37°, 41°, 50°, 59° and finally 68°F to give warming times of 1, 2, 3, 5 and 7½ days. After warming, the fruit was held at 68°F for ripening.

Ripening time is acutely sensitive to temperature. Fruit ripened to processing firmness between the third and fourth day after one to four hours warming to 68°F (graph 2). Thereafter, ripening was delayed in almost direct relation to the time required to reach 68°F. The ripening pattern was similar for both early and late season fruit.

A warming tunnel to warm pears rapidly and uniformly for ripening would readily adapt to existing cannery operations. Eight hundred bins a day could be warmed over a 12-hour period by conveying them through a warming tunnel that is two bins wide and eight bins long. Fuel consumption would be minimized and relative humidity kept high by a recirculating air flow system. If the warmer were placed in the ripening room, fuel required to warm fruit would be only slightly more than that required with the present common practice of stacking bins in the ripening room and using warm outside air as supplemental heat. About 60 cubic ft of natural gas or 0.65 gallons of propane is needed to warm a bin of pears from 30° to 68°F when the system is 70% efficient.

The warming tunnel concept has the advantage of assuring rapid, uniform warming and subsequent uniform ripening, and the conveyor line adapts well to many cannery operations. An alternate approach that would also assure rapid, uniform warming would be to use a fan and baffle arrangement to force 68°F air from the ripening room through the bins of fruit. This forced air concept is used extensively for fruit cooling. While not as rapid as a tunnel, it can cool (or warm) fruit in 8 to 16 hours.

The data presented here show the desirability of rapid and uniform warming of Bartlett pears destined for processing following cold storage. As little as one day's variation in reaching a core temperature of 68°F among fruits in a bin could result in an unacceptable variation in degree of ripeness for canning. This reflects the phenomenal rate of ripening between the second and fourth day after the fruit temperature reaches 68°F. If the variability in warming was two or more days, fruits with senescent breakdown and unripe hard fruits might be found within a bin. With more than three days variation, senescent and unripe fruit within a bin would be a certainty and many of the former would be mushy. In each case, the range in variation and the number of fruits affected would depend on the relative rate of warming between the most accessible and inaccessible positions in a bin or among bins. Even the most extreme conditions tested occur in some cannery operations in California.

Where Bartlett pears are promptly (within 24 hours after harvest) cooled to between 32° and 34°F, held at that temperature for three to five weeks, then warmed as described above, a processor should be able to program canning schedules with much greater precision than before and with much improved uniformity of ripening.

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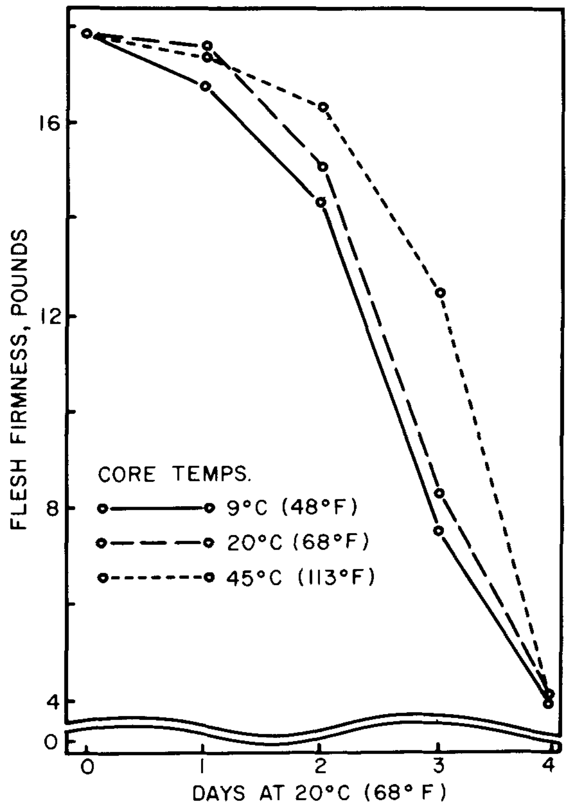
GRAPH 1. RATES OF SOFTENING OF BARTLETT PEARS WARMED WITH 110°F AIR FOR 15, 30 AND 120 MINUTES TO CORE TEMPERATURES OF 48°, 68° AND 113°F, RESPECTIVELY; THEN HELD AT 68°F



GRAPH 2. RATES OF SOFTENING OF LATE-SEASON BARLETT PEARS SUBJECTED TO DELAYS IN WARMING OF 1 HOUR TO 7½ DAYS FOLLOWING 5 WEEKS STORAGE AT 33°F