Vacuum cooling wrapped lettuce

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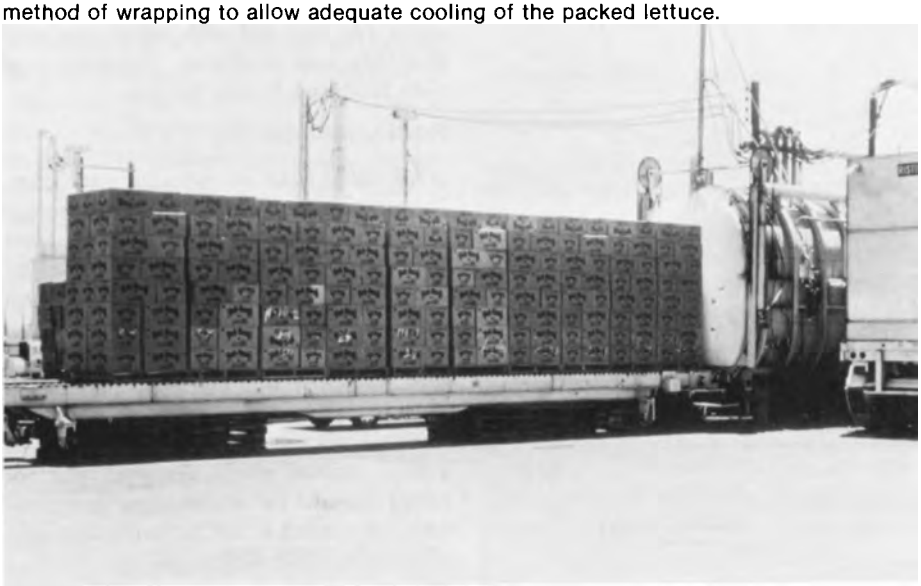
Cooperative work in lettuce production areas and at Davis has indicated that wrapped lettuce frequently does not receive adequate cooling during the vacuum cooling process that it undergoes. In the process water is evaporated ("boiled off") from the lettuce at a reduced pressure in a vacuum chamber, but if anything interferes with this vaporization, cooling is not achieved. This report concerns experiments examining the influence of commercially available film wraps on cooling, the wrapping procedure, and the cooler operation.

The effect of temperature on shelf life and decay is dramatic. Reducing temperature from 10° C (50° F) to 5° C (41° F) approximately doubles shelf life. Further reduction to 2.5° C (36.5° F) will generally result in another doubling of shelf life. The incidence and severity of decay, the most important factor in reduced salability, is even more sensitive to control through low storage temperature.

Workers are shown film-wrapping and packing head lettuce on a harvesting machine. Wrapped lettuce accounts for a significant portion (about 15 percent) of California's lettuce production. University research has shown the need for careful selection of the type and method of wrapping to allow adequate cooling of the packed lettuce.



Lettuce packed in cartons and loaded onto pallets awaits cooling in vacuum chamber at right. It is important that delays before or after cooling under ambient temperatures be minimized for best control of deterioration.

The mean temperatures attained during vacuum cooling were compared using lettuce (1) wrapped in various commercial films, (2) trimmed for wrapping but not wrapped, and (3) naked-packed. As expected, nonwrapped trimmed heads cooled the most and slightly more than nonwrapped, untrimmed heads, indicating that wrapper leaves interfere somewhat with vacuum cooling of the head. Least cooling was achieved with the unvented (nonperforated) film, which presented a severe barrier to moisture vaporization and transfer from the head. Lettuce wrapped with unvented film consistently had significantly higher after-cooling temperatures than that of the other treatments. Only vented films should be used for wrapping lettuce.

A high degree of variability in cooling was experienced with unvented film A, as indicated by the wide distribution of temperatures shown in figure 4. After cooling, more than 50 percent of the heads had temperatures higher than 3.3° C (38° F), and some were 10° C (50° F). The graph indicates better cooling with other treatments as indicated by a high percentage of heads having low temperatures. This includes the vented film treatment.

Film's effects

Cooling performance varied with the film, even when vented, and it varied with the amount of film applied to the head. Of three films tested, the "stretchier" or more pliable film provided the least cooling. Film A was the most pliable. However, results also depend on how taut the film is stretched. A possible explanation is that a tighter wrap decreases ventilation space between the lettuce and the film and this inhibits movement of vapor away from the head during cooling. Use of excessive film material that overlaps or completely covers the head in a double layer can block most of the vent holes. In severe cases, this can inhibit water vaporization and transfer and, consequently, the cooling obtained. Use of a film wrap of 45.7 cm (18 inches) provided

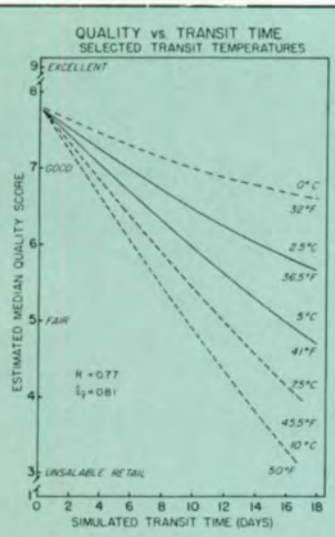


Figure 1. Effect of temperature and time on deterioration of coastal lettuce.

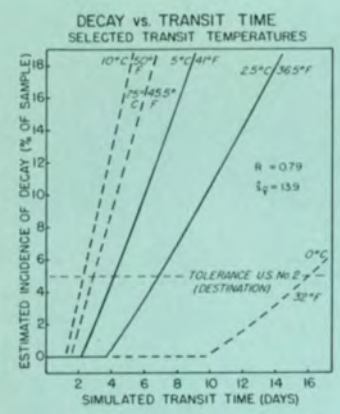


Figure 2. Effect of temperature and time on decay incidence on coastal lettuce.

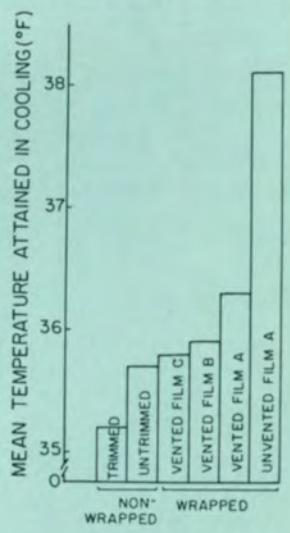


Figure 3. Average temperatures attained following vacuum cooling of unwrapped lettuce and lettuce wrapped in various commercially available films. The results of several experiments are combined.

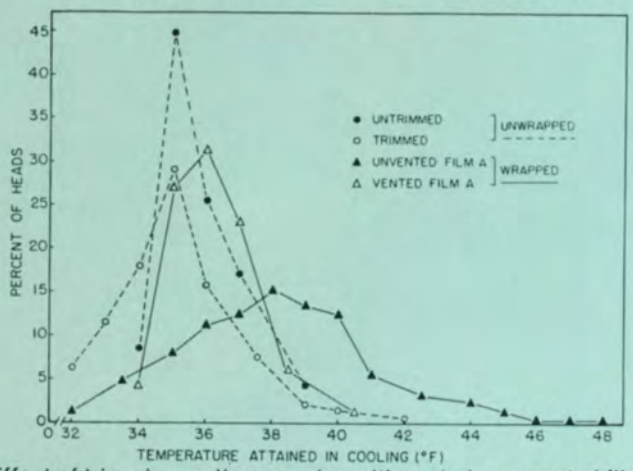


Figure 4. Effect of trimming and/or wrapping with vented or unvented film on uniformity of lettuce temperatures following simultaneous vacuum cooling.

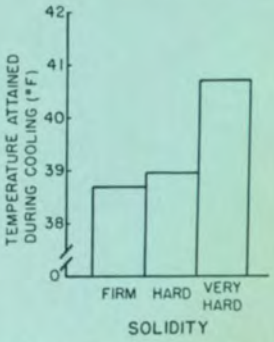


Figure 5. Average temperature attained following simultaneous cooling of lettuce of the indicated solidities.

a significantly greater temperature reduction (2° F) than use of an excessive size film wrap of 91.4 cm (36 inches). A 61.0 cm (24 inches) wrap produced intermediate results. Commercially wrapped lettuce varied in film size from 43 to 91 cm (17 to 36 inches), indicating that this factor contributes to higher temperatures and greater variation than desirable.

Two other factors, head solidity and vacuum cooling technique, were observed to influence temperature. Less-dense lettuce heads had a more favorable surface-to-mass ratio for vacuum cooling than dense heads, and this resulted in better cooling. The problem appears to be intensified with wrapped lettuce.

Vacuum cooling procedures are also very important in obtaining adequate cooling of wrapped lettuce. The process of "bouncing" or maintaining the lettuce in the tube for additional time at minimum safe pressures, tends to reduce the average and variation in product temperature. The best procedure for any given cooler operation depends on the kind of film, the solidity of the lettuce and the lettuce temperature before cooling.

The extent of cooling can be generally evaluated by computing an average load temperature, since for this type of temperature data the variability and the average decrease together. A good estimate of the average temperature of a given load may be obtained with 10 to 15 readings. If readings obtained vary widely, more observations are required to increase the accuracy of the mean. Such information may suggest adjustment of operating technique necessary to increase the uniformity of cooling. Temperatures need to be taken about 1 inch into the top of the compact portion of the lettuce head, while avoiding the stem. The procedure of 10 to 15 readings can be carried out in 3 to 5 minutes. This might be done three to four times a day, or when the nature (solidity) of the incoming product changes. To insure accuracy, periodic calibration of thermometers is required.

All film wraps and even wrapper leaves interfere somewhat with vacuum cooling by restricting movement of water vapor away from the lettuce heads during cooling. Perforated films should only be used because these restrict cooling the least. Only the minimum amount of film needed should be used to wrap each head. Overlapping the film restricts ventilation by blocking vents, and also wastes material. Shippers should consider the effects of the lettuce-film-tube combinations and adjust vacuum cooling procedures to compensate for variations in different films, initial product temperature, and different lettuce solidities. Poor cooling results in warmer temperatures during transit, which, depending on the transit time and physiological status of the lettuce, can result in poor arrivals.

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Their research was supported, in part, by the California Iceberg Lettuce Research Advisory Board.