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U. S. DEPARTMENT OF AGRICULTURE

Maintaining Produce Quality in

• RETAIL STORES

Agriculture Handbook No. 117
U. S. DEPARTMENT OF AGRICULTURE
Washington, D. C.

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ACKNOWLEDGMENTS

Material in this handbook is based principally on studies of the shelf life of many different fresh fruits and vegetables displayed in several retail-store types of cases, and from material published in U. S. Department of Agriculture Handbook No. 66, "The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks." The writer has drawn freely from published and unpublished findings of other staff members and from personal observations of handling practices in various producing areas and destination markets and their relation to quality and condition standards for various fresh fruits and vegetables.

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MAINTAINING PRODUCE QUALITY IN RETAIL STORES

By WILLIAM E. LEWIS, *senior horticulturist, Quality Maintenance and Improvement Section, Biological Sciences Branch, Marketing Research Division*

The retail store operator plays a very important part in the marketing of fresh fruits and vegetables. He is the last link in the long chain of handlers and is the only person with whom the consumer has direct contact. Unless the retailer offers fresh fruits and vegetables in a satisfactory condition to the consumer, direct or indirect losses may reflect back through each handler to the grower. The retail operator can do a great deal to protect the quality of produce.

Fresh fruits and vegetables displayed in retail stores are living on "borrowed time." Aging and other deterioration are continuous processes, the rate depending upon the commodity and the conditions under which it is held. Most fruits and vegetables are near or at the prime of life when harvested. They continue to live even after separation from the parent plants. The length of the post-harvest life depends largely upon temperature, moisture, and care in physical handling of the commodity. Cooling generally slows down aging and development of decay. Proper humidity aids in preventing loss of moisture that is essential to the living cell. Careful handling reduces unattractive bruises and broken skins that provide openings for decay organisms.

The purpose of this handbook is to provide information regarding desirable temperature and moisture conditions for daytime display, overnight holding, and storage of reserve supplies for short periods.[1] General principles are discussed and recommendations made for holding individual commodities under conditions that will aid retail-store operators in reducing losses and offer the consumer fresh, attractive produce. Many details are necessarily omitted. The information given should not be considered absolute or final but rather as a guide in handling the various products in retail stores.

Prepackaging

Prepackaging of various kinds of fresh fruits and vegetables has increased during recent years although most produce is still displayed in

[1] Information relative to extended storage is given in U. S. Dept. Agr. Handbook No. 66, The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. Sept. 1954.

bulk in retail stores.[2] Some kinds of produce, such as tomatoes in cardboard trays, and individual heads of lettuce are overwrapped in film; others, such as berries, brussels sprouts, and shelled lima beans, may be in trays or baskets with film-caps; and produce such as potatoes and oranges is prepackaged in film, paper, or mesh bags. Produce is frequently unitized in open containers or tied in bunches of the size most consumers want. Asparagus, celery hearts, and bananas may be tied or banded as individual consumer units; grapes may be displayed in open trays, and peaches in small open till baskets; and berries are displayed in small, open or film-capped baskets.

The shelf life of different prepackaged items varies considerably even under the best temperature and humidity conditions. For example, the shelf life of prepackaged carrots and radishes is longer than that of bulk carrots and radishes because the highly perishable tops have been removed and the roots protected in moisture-retentive bags. The reverse is true of cut beans and shredded cabbage which need refrigeration more than the uncut form. Most recommendations given in this handbook concerning temperature and humidity requirements and display practices for bulk produce apply also to prepackaged produce. Obviously, the recommendations for sprinkling with water do not apply to prepackaged produce.

Effect of Previous History on Shelf Life of Produce

The previous history of the produce has an important effect upon the length of time it will remain in salable condition in the retail store. Poor growing conditions, delays in moving produce through marketing channels, and rough handling often result in shortened shelf life of fresh fruits and vegetables. Excessive rainfall or long periods of drought, or very hot or very cold weather during the growing season, may cause injuries to produce before it is harvested. These injuires may or may not be visible. Delays in moving produce through various handling and shipping operations provoke common and sometimes unavoidable situations that result in aging and other deterioration of fresh fruits and vegetables. Produce held too long in cold storage deteriorates rapidly on removal to higher temperatures. Careless or indifferent physical handling of packed containers often causes excessive bruises or severe cuts or breakage of tender, highly perishable produce. Produce that is sensitive to cold and has been subjected to an accumulation of low temperatures previous to arrival at the retail store will develop chilling injury quicker under unfavorable refrigeration at the store than produce grown and marketed during warm weather. Such unfavorable conditions often are the cause of wide varia-

[2] Donald R. Stokes, Marketing Research Division, AMS, in a report presented at American Management Association Prepackaging Conference, Chicago, Ill., April 1955, states that estimates indicate that only about 20 percent of fresh fruits and vegetables are marketed in consumer packages.

tions in the keeping quality of fresh fruits and vegetables at the retail store.

Care of Produce on Arrival at Retail Store

Fresh produce is subject to deterioration when allowed to remain in the hot sun for several hours or exposed to freezing temperatures on receivers' platforms. Produce that needs refrigeration should be placed in cold rooms as soon as possible after arrival at the store, and those commodities that may be injured by chilling should be moved to rooms with suitable temperatures.

Rough Handling Lowers Quality

The seriousness of rough handling of fresh produce cannot be overemphasized. Rough handling, whether occurring in the field, in and out of packinghouses, trucks, railroad cars, wholesale produce houses, or in retail stores, may result in considerable damage to fresh fruits and vegetables. Throwing produce into picking or shipping containers, packing containers too tightly or too loosely, or dropping packed containers often result in serious damage to the quality and condition of the commodity. Too often produce that has received the best of care regarding temperature and moisture is so carelessly handled that badly bruised, cut, or broken and decayed specimens are found when the package is unpacked at the retail store.

Rough handling of produce during preparation for display and when removed from the racks at night and careless handling by customers frequently result in serious loss of quality. When produce is arranged on the display racks it should be placed, not thrown, into position. Throwing produce onto the racks sometimes causes bruises and cuts that are not apparent at the time; it may become soft, discolored, and possibly decayed. Rough handling by the customer may be lessened to a considerable extent by arranging the produce on the racks so that selections can be made without digging into the display. Frequent picking over of produce by customers causes such an accumulation of bruises and other injuries that the display suffers loss of quality and becomes unattractive.

Importance of Quality to Impulse Buying

Impulse buying of fresh fruits and vegetables by the consumer depends upon the attractiveness of the display. The effect of mass display or attractive prices may be dulled by the presence of wilted, shriveled, spotted, or decayed produce. A single decayed fruit or vegetable in the display may create doubt in the mind of the customer regarding the keeping quality of the remainder of the lot. To induce impulse buying, displays should be free from decay and unsightly discoloration; and the produce should look clean, fresh, and attractive.

Washing Produce

Washing produce to maintain and improve quality before it is placed on the display racks is practiced in many retail stores. Washing not only cleans but "freshens" produce. Rough handling during washing operations should not be permitted. Reasonable care will lessen unsightly bruises, cuts, and broken stems and leaves. The washing water should be kept clean to prevent spreading disease organisms throughout the lot.

Fruit and Vegetable Display Cases

Various methods are used to maintain desirable temperatures of fresh fruits and vegetables in retail stores. Mechanically refrigerated and ice-bed cases maintain desirable temperatures during both day and night, while produce displayed in nonrefrigerated cases during the daytime may be stored at night in fruit and vegetable storage rooms or in iced produce barrels.

There are many different types of mechanically refrigerated display cases, including open and closed convection or gravity-flow, and forced-circulation types. Closed cases may be used advantageously in stores where the produce is often held for several days before it is sold. In this type of case, temperatures and moisture are more easily controlled than in open cases because the produce is less subject to drafts and changes in display room atmosphere. The open-top case is more suitable for stores that have a rapid turnover and where it is desirable to have the produce more readily accessible to the customer.

Mechanically refrigerated by convection or gravity-flow

In the open convection-type case, refrigeration of produce is based on the principle that cold air sinks and warm air rises. As air passes over refrigerated coils and is cooled, it sinks to the bottom of the case, passes under and up through the display where it is warmed by heat removed from the produce. This warmed air flows back over the refrigerated coils where it is re-cooled and follows the path of the cold air preceding it.

Temperatures in the convection-type case depend upon the depth and the distance of the produce from the coils. The practice of displaying produce on wooden boxes, crates, or inverted baskets to raise the display results in the produce being placed farther from and insulated against the source of refrigeration. Accordingly, higher temperatures occur in produce displayed on these false racks than in produce displayed on the regular rack supplied with the case, as will be discussed later. Slow moving produce should not be piled above the top front edge of convection-type cases. High temperatures may be expected in the upper layer when the produce is piled too high on the racks. Covering produce at night with wet canvas or heavy paper will aid in preventing loss of moisture and refrigeration.

Mechanically refrigerated by forced-circulation

In the mechanically refrigerated case with forced-circulation, fans move the air over and through the produce from which heat is picked up. The air then returns through ducts to the refrigerated coils where it is re-cooled and re-circulated. The forced circulation of cold air over the top of the produce permits the display of produce in a desirably high, prominent position in the case. This air-flow over the top layer, however, may cause some wilting, especially if the fan speed is too great. Allen and Pentzer [3] found that doubling the rate of air movement increased moisture loss by about one-third. Moisture loss may be minimized by sprinkling the produce with water several times daily. Covering the produce at night with wet canvas or heavy paper will lessen wilting or drying. The covering should be arranged so that the circulation of air is not obstructed.

Ice-bed case

Low temperatures and high humidity are readily obtained with proper use of the ice-bed case. Arrange the produce on a 3- to 5-inch bed of crushed ice each morning and then cover it immediately with a thick layer of ice for best results. Much of this garnish ice will soon melt and leave the produce fresh and crisp when the early customers arrive. At noon and at midafternoon, a light garnish of ice will keep the produce cool and moist. In some stores the produce is sprinkled with water instead of being garnished with ice during the daytime. Although sprinkling retards wilting and drying, it does not cool the produce in the upper layers, and water from sprinkling, especially if heavily applied, will melt some of the ice in the bed of the case. Whether garnished with ice or sprinkled with water, a thick layer of ice should be spread over the produce when it is prepared for night storage, and the whole covered with canvas or heavy paper. Produce garnished with ice or sprinkled with water usually increases in weight (table 1).

Nonrefrigerated case

Nonrefrigerated cases may be used to display continuously fruits and vegetables that do not need refrigeration or that may be injured by low temperatures; these cases may also be used for other produce that is stored at night in iced produce barrels or in cold storage rooms. Most fruits and vegetables that will be sold during the first day may be displayed without refrigeration, but produce that does best at low temperatures should be kept as cool as available refrigeration will permit. In some stores, a thin layer of crushed ice is spread over the top of the produce but no ice is used underneath. This method is intermediate between the

[3] Allen, F. W., and Pentzer, W. T. Studies on the effect of humidity in the cold storage of fruits. Amer. Soc. Hort. Sci. Proc., 33: 215–223, illus., 1936.

TABLE 1.—*Weight changes in produce as affected by different handling practices in an ice-bed case*

Commodity	Weight change of produce								
	Garnished with ice 3 times daily and covered with thick layer of ice at night			Sprinkled with tap-water 3 times daily and covered with thick layer of ice at night			Not garnished or sprinkled days but covered with thick layer of ice at night		
	1 day	2 days	3 days	1 day	2 days	3 days	1 day	2 days	3 days
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Beans, snap	+1	+4	+6	+1	+4	+5	0	+1	+1
Beets, bunched	+5	+7	+8	+4	+6	+8	+1	+1	+3
Broccoli, sprouting	0	+1	+1	+2	+4	+5	−1	−1	−1
Carrots, bunched	+1	+3	+5	+2	+3	+3	0	0	0
Cauliflower	+2	+3	+3	+2	+2	+3	0	−1	−1
Cucumbers	0	0	0	0	0	0	0	0	0
Lettuce	+1	+1	+1	+1	+1	+1	0	0	−1
Onions, green	+4	+6	+7	+3	+5	+7	0	+2	+3
Radishes, bunched	+4	+6	+5	+3	+3	+4	0	+2	+2

usual practice followed in using the ice-bed case, and that of displaying produce without refrigeration during the daytime. Garnish ice spread over produce displayed on a nonrefrigerated rack provides some cooling, and water from melting ice provides moisture that minimizes wilting and drying of the produce. Tests by Hansen and McColloch [4] showed that the average produce temperature of about 58° F. was low enough to check somewhat the development of spoilage, but after 2 days the quality deteriorated faster than in the ice-bed case where ice beneath the produce resulted in lower temperatures.

Temperatures in Display Cases

Refrigeration slows respiration in fresh fruits and vegetables. Generally, the lower the respiration, the slower the loss of quality. Produce displayed in retail stores, however, does not require the low temperatures needed for extended storage. Temperatures of 40° to 50° F. will keep most produce in satisfactory condition for 3 or 4 days.

Loss from unnecessary deterioration of fresh fruits and vegetables may be reduced if produce temperatures in different parts of display cases are known. Although temperatures often found in the lower layer in refrigerated display cases are highly desirable for some kinds of produce, they

[4] Hansen, J. C., and McColloch, L. P. Effect of Temperature and Moisture on the Shelf Life of Fresh Produce. U. S. Bur. Plant Indus., Soils, and Agr. Eng. Handling, Transportation & Storage Off. Rpt. No. 213, 13 pp., illus. July 1949.

may cause chilling injury to others that are sensitive to temperatures below 40° F.

The differences in temperatures of produce displayed in several types of cases, at various positions, are given in figure 1. Temperatures of produce displayed in the ice-bed case and in both types of mechanically refrigerated cases were materially higher in the top layer than in the bottom. In the convection-type case, temperatures of produce displayed on a raised false rack were considerably higher than those of produce on the regular rack. Temperatures in the top layer on the false rack were only a few degrees lower than that of produce displayed continuously without refrigeration.

The depth to which produce is piled in a display case may cause wide variations in the temperatures between the bottom and top layers. Differences of 25 to 30 degrees between the 2 layers have been noted in produce piled 12 inches deep. The temperatures of produce in various positions when piled at different depths in the display case are shown in the cross-section diagrams in figure 2.

Relatively high temperatures in produce displayed continuously without refrigeration, or in the top layer on raised false racks in convection-type cases, favor decay and rapid deterioration of lettuce, bunched beets, and other kinds of produce that require low temperatures for best shelf life.

Overnight Storage

Fruit and vegetable storage rooms and iced barrels may be used to refrigerate produce during the night after daytime display without refrigeration. The cooling effect of night refrigeration carries well into the following day when the produce is displayed again on nonrefrigerated racks (fig. 3). Tests have shown that the average daytime temperatures of produce held overnight in 32° and 40° F. storage rooms averaged 13 and 15 degrees, respectively, below the average temperatures of produce displayed continuously without refrigeration. The average 24-hour temperature of produce held overnight in a 40° storage room, or in an iced barrel, averaged approximately 50° and that of produce stored in a 32° room, averaged about 45°. These 24-hour temperatures were approximately 20 and 25 degrees, respectively, below the average 24-hour temperatures of produce held continuously without refrigeration.

Iced produce barrels (fig. 4) may be used to refrigerate produce during the night. A stout wooden barrel or metal drum,[5] provided with a drain and a slatted false bottom, is suitable for this purpose. A barrel of about 50 gallons capacity will hold 100 to 125 pounds of produce in addition to the ice. Two or three inches of crushed ice is spread over the slatted rack in the bottom. The barrel is then filled with alternate layers of produce and crushed ice, and a wet burlap sack or other suitable

[5] Average temperatures of produce held overnight in the wood barrel and the metal drum varied less than 1 degree.

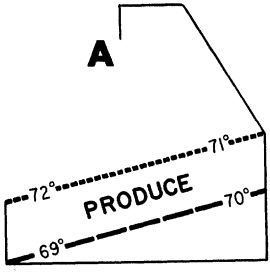
material is placed over the top. About 10 to 12 pounds of ice is used in the bottom, 6 to 8 pounds between layers, and about 12 pounds over the top layer of produce. This will require from 50 to 90 pounds of ice daily. The packed barrel of produce may be left in the display room during the night.

Produce stored overnight in the iced barrel increased in weight more than that held at night in a storage room at 40° F. (table 2).

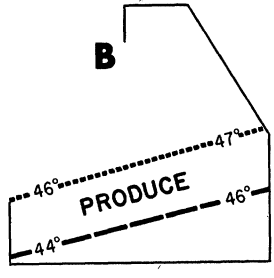
Storage of Reserve Supplies

For short storage of reserve supplies (generally less than one week), fresh fruits and vegetables may be classed into two groups based on

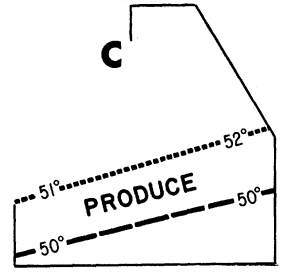
NONREFRIGERATED RETAIL-STORE DISPLAY CASE



No refrigeration. Average temperature of produce, 70° F.



No refrigeration during day; in storage room at 32° F. during night. Average 24-hour temperature of produce, 46°.

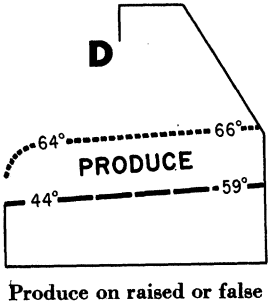


No refrigeration during day; in 40° storage room at night. Average 24-hour temperature of produce, 51°.

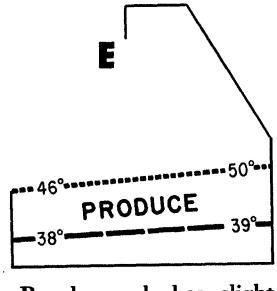
OPEN, MECHANICALLY REFRIGERATED CASES

(Produce sprinkled with tapwater 4 times daily and covered with heavy paper at night.)

Convection or Gravityflow Type

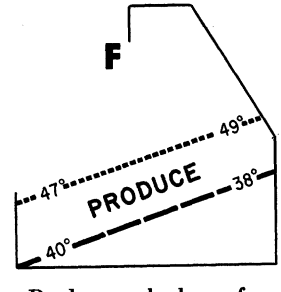


Produce on raised or false rack. Average temperature of produce, 60° F.



Regular rack has slight slope from front to back of case. Average temperature of produce, 43° F.

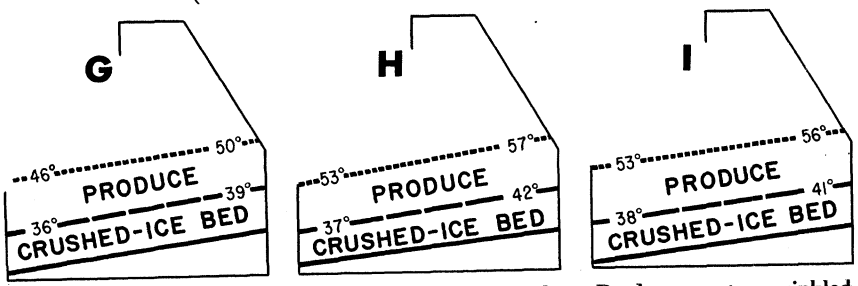
Forced-Circulation Type



Produce rack slopes from about 1 inch at front to 12 inches at back. Average temperature of produce, 43° F.

ICE-BED CASE

(Produce covered with thick layer of ice at night)



Produce garnished with ice during day. Average temperature of produce, 42° F.

Produce sprinkled with tapwater during day. Average temperature of produce, 47° F.

Produce not sprinkled with water or garnished with ice during day. Average temperature of produce, 47° F.

Figure 1.—Effect of position in display case on temperature of 8 to 13 fruits and vegetables piled 6 to 8 inches deep. Temperatures were taken during 18 to 46 testing periods. The weekly temperature of the display room ranged from 74° to 77° F., and averaged 75°.

temperature requirements. The first group should include kinds of produce that require refrigeration, and the second those that may be held in satisfactory condition at room temperatures (65° to 75° F.) for several days. A cold storage room equipped to provide temperatures of 40° to 45° could be used for the first group, while ordinary room temperatures would be satisfactory for such commodities as potatoes, sweetpotatoes, winter squash, and bananas.

Meat coolers provide the only available refrigeration in some of the smaller stores. Some fresh produce might be seriously damaged by freezing or chilling if stored at temperatures suitable for preserving meat.

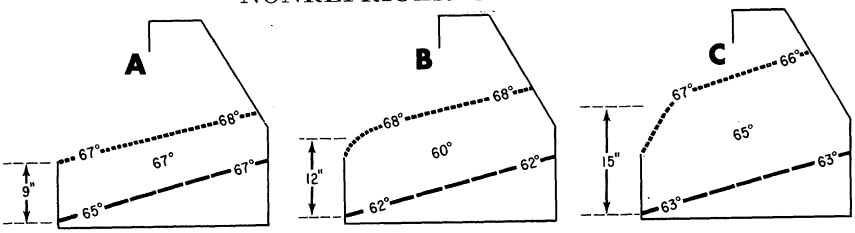
Produce that requires some refrigeration but is sensitive to temperatures below 45° F. if exposed to them for several days, may be held overnight in a 40° room. A brief summary indicating the suitability of different temperatures for various commodities held for a short period in retail stores is given in table 3.

Where different kinds of produce are stored together for more than a day or so, a cross-transfer of odors may be expected. Combinations that may result in a transfer of odors are apples with celery, cabbage, potatoes, and onions; celery with onions; and citrus fruits with any of the strongly scented vegetables. Odors from apples, onions, and other strongly scented produce are readily absorbed by dairy products. Pears and apples take on an earthy flavor when stored with potatoes.

Moisture Control Important

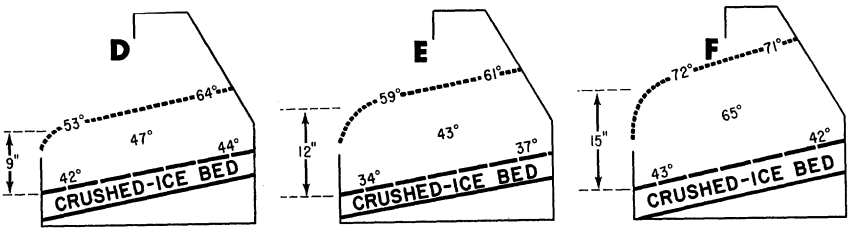
The living cells of fresh fruits and vegetables consist mostly of water—water essential to the life of the cell and to the preservation of a fresh,

NONREFRIGERATED CASE



Produce in A, B, and C is displayed without refrigeration during the day, and is stored in 45° to 50° F. room at night.

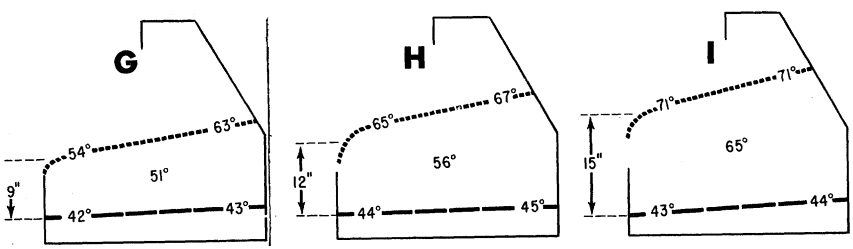
ICE-BED CASE



Produce in D, E, and F is garnished with crushed ice 3 times a day and is covered with a thick layer of ice and heavy paper at night.

MECHANICALLY REFRIGERATED CASE

Open top, convection type



Produce in G, H, and I is sprinkled with tapwater 4 times daily and covered with heavy paper at night.

Figure 2.—Effect of depth to which fruits and vegetables are piled in the retail-store display case on temperature of the produce. Temperatures are averages of 12 to 17 daytime readings at each position over a period of 4 to 5 days. Display room air temperatures ranged from 75° to 84° F., and averaged 81°. The dotted line represents the top of the produce, and the dash line the rack on which produce is placed. Depth of produce on the racks is indicated at left of each diagram.

tasty, succulent commodity. With some kinds of produce, such as onions, drying is necessarily a part of the curing process, but with most fresh fruits and vegetables loss of moisture results in wilting and drying that detracts from the appearance and general quality of the commodity and may also result in loss of nutritional value.

Retention of moisture in fresh produce can be aided by control of moisture in the surrounding air. When the relative humidity is low, the com-

TABLE 2.—*Effect on weight of produce of storing at night in metal barrel, in wood produce barrel, and 40° F. storage room, after daytime display without refrigeration*[1]

Commodity	Gain or loss in weight of produce displayed on non-refrigerated rack during day, sprinkled 4 times daily, and stored at night in—								
	Metal produce barrel after being displayed—			Wood produce barrel after being displayed—			40° F. room after being displayed—		
	1 day	2 days	3 days	1 day	2 days	3 days	1 day	2 days	3 days
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Beans, green	+3	+5	+7	+2	+4	+6	+2	+2	+4
	+4	+7	+11	+5	+8	+11	+1	+2	+3
Broccoli	+5	+7	+8	+5	+6	+8	+4	+4	+6
	+4	+4	+5	+4	+5	+5	+3	+3	+3
Cabbage	+1	+1	+2	+1	+2	+2	+1	0	+1
	+1	+1	+2	0	+1	+1	−1	−1	−1
Carrots, bunched	+4	+5	+5	+5	+6	+5	+3	+4	+4
	+4	+6	+8	+5	+9	+9	0	+2	+1
Cauliflower	+2	+3	+2	+2	+4	+3	+2	+2	+2
	+2	+3	+5	+2	+3	+4	0	−1	−2
Lettuce	+3	+5	+13	+3	+5	+18	+2	+2	+11
	+2	+3	+4	+3	+2	+4	0	0	0
Onions, green	+2	+4	+2	+4	+6	+4	−1	−2	−5
Average	+2.8	+4.2	+5.7	+3.2	+4.7	+6.2	+1.2	+1.3	+2.1

[1] Results are of 2 tests on all the vegetables except onions.

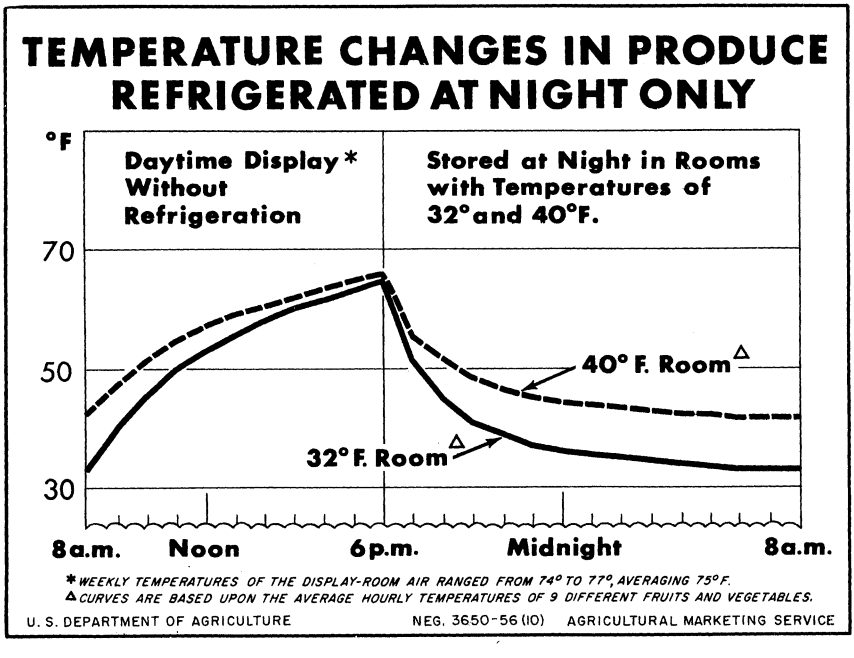


Figure 3.

TABLE 3.—*Suitability of various temperatures for holding fresh fruits and vegetables in retail stores* [1]

Commodity	Produce temperatures—° F.			
	32° to 35°	40° to 50°	55° to 60°	65° to 75°
Apples	Best [2]	Good	Fair	Too high.
Apricots	Best	Good	Fair	Too high.
Artichokes	Best	Good	Fair	Too high.
Asparagus	Best	Fair to good	Fair	Too high.
Avocados, for ripening.	Too low	Too low	Good	Best.
Avocados, full-ripe.	Too low	Best	Fair to good	Too high.
Bananas, for ripening.	Too low	Too low	Too low	Best.
Bananas, full-ripe	Too low	Too low	Best	Too high.
Beans, snap	Too low	45°–50° best	Good	Fair.
Beans, lima	Best	Good	Fair	Too high.
Beets	Best	Good	Fair	Too high.
Berries (strawberries, raspberries, blackberries).	Best	Fair to good	Fair	Too high.
Broccoli, sprouting	Best	Good	Too high	Too high.
Brussels sprouts	Best	Good	Fair	Too high.
Cabbage	Best	Good	Good	Fair.
Carrots	Best	Good	Fair	Too high.
Cauliflower	Best	Good	Fair	Too high.
Celery	Best	Good	Fair	Too high.
Cherries	Best	Fair to good	Fair	Too high.
Collards	Best	Good	Fair	Too high.
Corn, sweet	Best	Fair	Too high	Too high.
Cranberries	Too low	Best	Good	Fair.
Cucumbers	Too low	Best	Good	Fair to good.
Dates	Best	Good	Good	Fair.
Eggplant	Too low	Best	Good	Too high.
Endive, escarole	Best	Good	Fair	Too high.
Figs, fresh	Best	Fair to good	Fair	Too high.
Grapefruit	Good	Good	Good	Fair to good.
Grapes	Best	Good	Fair	Too high.
Kale	Best	Good	Fair	Too high.
Leeks, green	Best	Good	Too high	Too high.
Lemons	Good	Best	Good	Fair.
Lettuce	Best	Good	Fair	Too high.
Limes	Too low	45°–50° best	Good	Fair.
Mangoes	Too low	Fair	Best	Fair.
Melons, for ripening.	Too low	Too low	Good	Fair.
Melons, full-ripe	Too low	Best	Fair to good	Too high.
Mushrooms	Best	Fair	Too high	Too high.
Nectarines, for ripening.	Too low	Too low	Fair to good	Best.
Nectarines, full-ripe.	Best	Good	Fair	Too high.
Okra	Too low	Best	Fair	Too high.
Onions, dry (see text, page 25).				
Onions, green	Best	Fair	Too high	Too high.
Oranges	Best	Good	Good	Fair to good.
Parsnips	Best	Good	Good	Fair.
Peaches, for ripening.	Too low	Too low	Fair to good	Best.

See footnotes at end of table.

TABLE 3.—*Suitability of various temperatures for holding fresh fruits and vegetables in retail stores*[1]—Continued

Commodity	Produce temperatures—° F.			
	32° to 35°	40° to 50°	55° to 60°	65° to 75°
Peaches, full-ripe	Best	Good	Fair	Too high.
Peas, green	Best	Fair to good	Too high	Too high.
Pears, for ripening	Too low	Too low	Good	60°–70° best.
Pears, full-ripe	Best	Good	Fair	Too high.
Peppers, green	Too low	Best	Fair	Too high.
Persimmons, for ripening.	Too low	Fair	Good	Best.
Persimmons, full-ripe.	Best	Good	Fair	Too high.
Pineapples, for ripening.	Too low	Too low	Fair	Good.
Pineapples, full-ripe.	Good	Best	Fair	Too high.
Plums (including prunes), ripe.	Best	Good	Fair	Too high.
Potatoes (see text page 27).				
Pumpkins and winter squash.	Too low	Too low	Best	Good.
Squash, summer (soft-skin types).	Fair to good	Best	Fair	Too high.
Radishes	Best	Good	Fair	Too high.
Rhubarb	Best	Good	Fair	Too high.
Shallots	Best	Fair	Too high	Too high.
Spinach	Best	Fair to good	Too high	Too high.
Sweetpotatoes	Too low	Too low	Best	Good.
Tangerines	Best	Good	Fair	Too high.
Tomatoes, for ripening.	Too low	Too low	Fair to good	60°–70° best.
Tomatoes, full-ripe.	Good	Best	Fair	Too high.
Turnips	Best	Good	Good	Too high.
Rutabagas	Best	Good	Good	Good.

[1] Recommendations are for produce displayed on racks in retail stores a maximum of about 4 days and for storage of reserve stocks for less than 1 week. For details on each item, see pages 14–30.

[2] Explanation of terms used:
Best, most desirable temperatures.
Good, satisfactory temperatures for 3 or 4 days' display.
Fair, satisfactory temperatures for 1 or 2 days' display.
Too low, produce subject to chilling injury.
Too high, produce subject to rapid aging and decay.

modity will lose moisture to the surrounding air. Sprinkling the produce with water or garnishing it with ice reduces this moisture loss and usually aids in prolonging the attractiveness of produce (table 4).

The relative humidity of the air in the display room determines how often sprinkling is needed. In dry climates, more frequent sprinkling may be necessary than in areas where the humidity is high. When temperatures are high, decay develops rapidly if there is too much moisture; sprinkling under such conditions should be held to a minimum. At low temperatures sprinkling is not likely to be harmful, and the produce will remain in good condition longer if the necessary moisture is supplied.

Produce displayed in the upper layers of display cases is much more subject to moisture loss and wilting than that in the lower layers. Light sprinkling of the upper layers of produce is effective in minimizing wilting. Heavy wetting throughout the produce may cause waterlogging of some kinds of produce, especially when displayed without refrigeration during the daytime. Matting of watersoaked leaves of such commodities as bunched beets, bulk spinach, and other leafy vegetables may lead to decay.

In a large number of tests with 10 different vegetables in refrigerated and in nonrefrigerated cases, the average temperature difference between the sprinkled and nonsprinkled produce was less than one-half degree.

Temperature Requirements

Temperature requirements vary with different fruits and vegetables. Some commodities keep best at room temperatures (65° to 75° F.). For long storage periods most commodities need temperatures as low as 31° or 32°, although some are injured at temperatures below 45° or 55°.

TABLE 4.—*Attractiveness of produce as affected by sprinkling with water, garnishing with ice, and not sprinkling or garnishing* [1]

Display and storage	Percentage of lots attractive at end of 1, 2, and 3 days								
	1st day			2d day			3d day		
	Not sprinkled or garnished	Sprinkled	Garnished daily	Not sprinkled or garnished	Sprinkled	Garnished daily	Not sprinkled or garnished	Sprinkled	Garnished daily
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
On nonrefrigerated rack during daytime:									
In 32° F. room at night	100	100	.....	76	94	.....	47	65	.....
In 40° F. room at night	90	97	.....	83	83	.....	41	55	.....
In mechanically refrigerated, open convection-type case: [2]									
On regular rack	97	97	.....	76	93	.....	59	76	.....
On false bottom	91	91	.....	73	73	.....	41	32	.....
In ice-bed case continuously [3]	[4] 100	100	100	[4] 95	96	97	[4] 86	88	83

[1] Produce included: snap beans, bunched beets, broccoli, cabbage, bunched carrots, cauliflower, cucumbers, lettuce, green onions, and bunched radishes.
[2] Produce covered at night with heavy paper or canvas.
[3] Produce covered at night with thick layer of ice over which heavy paper or canvas was placed.
[4] Produce was not garnished with ice or sprinkled with water during the day but was wet each morning from the ice used at night.

Differences in the inherent keeping quality of fruits and vegetables, while not always apparent, may result in considerable variation in the

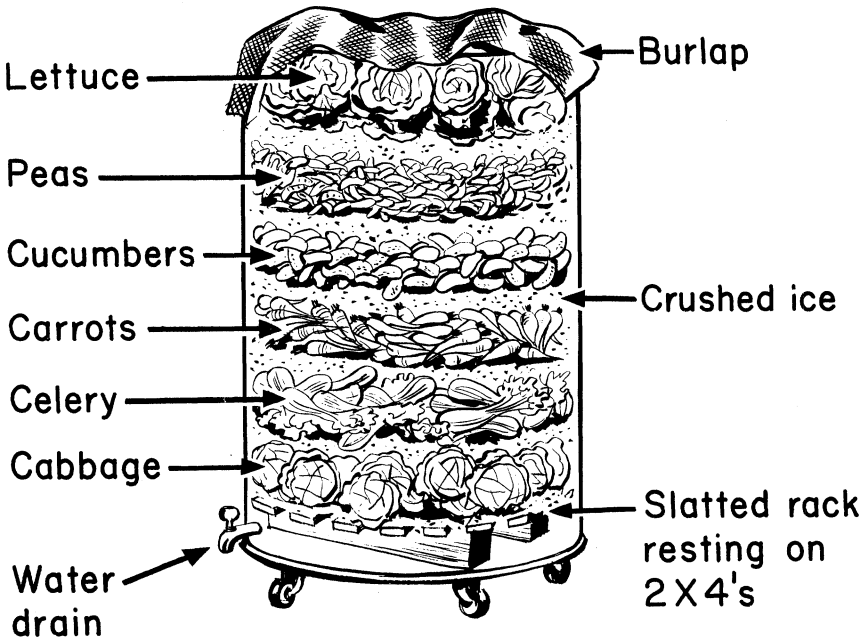


Figure 4.—The produce barrel packed with alternate layers of vegetables and crushed ice for night storage.

time produce will remain in good condition at any given temperature. Recommendations given in table 3 and elsewhere in this handbook apply to produce that appears to be in reasonably good condition. Frequent inspections should be made during the day to observe changes in quality before material losses occur. Produce showing early signs of deterioration should be given temporary temperature preference over similar sound commodities. However, it should be quickly sold—at a reduced price, if necessary.

Detailed descriptions of temperature and moisture requirements for a number of fresh fruits and vegetables displayed in retail stores are given in the following pages. They apply to produce in reasonably good condition that may be displayed about 4 days or less on racks in retail stores, or stored as reserve supplies for about 1 week.

Apples

Apples of good quality and condition may be displayed for several days on nonrefrigerated racks. Refrigerated apples, however, retain a bright, attractive appearance and crisp texture longer than nonrefrigerated apples. Without refrigeration, apples age more rapidly, feel oily to the touch, and soon develop a mealy texture. Apples in an advanced stage of ripeness deteriorate rapidly and may soon become worthless if not refrigerated or sold. The principal factors of deterioration that may be retarded by refrigeration are softening of the flesh, internal breakdown, discoloration of bruises, and decay.

Reserve supplies of apples may be held satisfactorily for short periods at temperatures of 32° to 50° F., the lower temperature giving the best results.

Apricots

Apricots are highly perishable and should be moved quickly into consumer channels. They will keep well for a few days at temperatures of 32° to 50° F. in a relative humidity of 85 to 90 percent.

Artichokes

The true artichoke, a member of the thistle family, is known to the trade as the globe artichoke. The edible bud, made up of a cone of short, thick-stemmed leaves, is seldom stored. For temporary holding, a temperature of about 32° F. is preferable, with a relative humidity of 90 to 95 percent to prevent drying and wilting. However, artichokes should keep satisfactorily for several days at display temperatures of 40° to 50°. Artichokes often show brown discoloration of the outer leaves, which may be caused by bruises or by freezing. At cool temperatures, artichokes may be lightly sprinkled to minimize wilting and drying, but at warm temperatures, sprinkling with water encourages the development of decay where water settles between the leaves.

Asparagus

Fresh asparagus deteriorates rapidly at temperatures above 32° F. In retail stores, it should be displayed at temperatures as low as 32° if available equipment permits. The original tenderness of fresh asparagus, which at ordinary room temperatures is lost soon after cutting owing to the formation of woody tissue, is preserved at low temperatures. Furthermore, after the asparagus is cut, the sugar content, which contributes to the flavor, rapidly diminishes at temperatures above 32°; if the produce is put in storage at 32° F. immediately after cutting, the sugar content remains practically unchanged. Therefore, the sooner asparagus is placed in proper storage after harvesting the better its condition will be when used. Asparagus is likely to lose a great deal of water in storage or in transit if the stalks are not stood on wet moss or other moist absorbent material. Garnishing asparagus with ice or sprinkling it with water on refrigerated display racks will preserve the quality longer.

Avocados

Aging and softening of ripe avocados can be retarded by holding at a temperature of about 45° F., but they should not be displayed for more than a few hours at temperatures below 45°. At lower temperatures, avocados are subject to cold injury in the form of brown to black discolored flesh. A relative humidity of 85 to 90 percent is desirable. Avocados are usually displayed without refrigeration for short periods.

Bananas

Green bananas ripen at temperatures of 62° to 70° F. and in a relative humidity of 85 to 90 percent. After ripening, aging and softening of fruits will be delayed if the bananas are held at temperatures of 56° to 60°. At temperatures below 56° bananas will become chilled and the peel injured. Both green and ripe bananas are susceptible to chilling. Fruit chilled in the green stage develops a dull smoky color. Fruit chilled after ripening develops a dull-brown color when later exposed to higher temperatures and is very susceptible to handling marks; the slightest bruising causes discoloration of both peel and flesh. Prolonged exposure to high temperatures results in poor color and hastens decay. Ripe bananas are extremely perishable.

Beans, Lima

Unshelled lima beans can be expected to keep in good condition for several days at temperatures of 32° to 45° F. Shelled lima beans are much more perishable than the unshelled and will deteriorate rapidly at room temperatures. The shelled beans should be held at as low temperatures as practical to control stickiness, spotting, and loss of sweetness, succulence, and vitamin content. Unless the shelled beans can be refrigerated at 32° to 40°, they should be quickly moved into consumer channels. Studies by Brooks and McColloch [6] showed that high humidity favors the development of stickiness and spotting. On the other hand, too low humidity may result in severe shriveling. It is not advisable to sprinkle shelled lima beans, especially at high temperatures, but the unshelled beans may be lightly sprinkled with water.

Beans, Snap

Snap beans do not require as low temperatures as many other commodities; they may be displayed satisfactorily for a few days at temperatures of 45° to 55° F. The beans are subject to russeting and some pitting when held continuously below 45° for several days. Snap beans that have been stored 3 to 5 days at 32° to 40°, and are then removed, will usually develop pitting and russeting in about 1 day during warm weather. However, if displayed on nonrefrigerated racks during the daytime, night storage in 40° to 45° coolers with a relative humidity of 85 to 90 percent will give satisfactory results for 2 or 3 days. Sprinkling snap beans with water or garnishing them with crushed ice will prolong their shelf life by preventing moisture losses that cause drying and flabbiness.

Beets

Bunched beets, especially the tops, are highly perishable. Since low temperatures help retard the development of decay of the tender, leafy

[6] Brooks, Chas., and McColloch, L. P. Stickiness and Spotting of Shelled Green Lima Beans. U. S. Dept. Agr. Tech. Bul. No. 625, July 1938.

tops, beets should be kept as cool as possible. Display temperatures of 50° F. or lower are desirable, and even temperatures as low as 32° will not injure beets but will prolong their shelf life. Bunched beets that have been displayed during the daytime on nonrefrigerated racks should be stored under refrigeration at night.

Sprinkling with water or garnishing with crushed ice aids in preventing sponginess of the roots and wilting of the leaves. Beets in the upper layers in the display are usually the first to become wilted and spongy, while those in the lower layers generally remain crisp and firm. Light sprinkling is advisable when beets are displayed at low temperatures, but little sprinkling of the leaves should be done at high temperatures, especially if the air is very humid. Heavy sprinkling may cause the leaves to become matted, and, when temperatures are high, decay develops quickly if there is too much water. Only enough water to keep the beets moist in the upper layers should be applied. If these are sufficiently moist, those in the lower layers will be also. The tops should be loosened occasionally to prevent matting of wet leaves.

Reserve supplies of both bunched and topped beets may be held at temperatures of 32° to 45° F. in a relative humidity of 80 to 90 percent. Crushed ice spread over the beets provides both low temperature and desirable moisture conditions.

Berries

Berries such as strawberries, raspberries, blackberries, dewberries, blueberries, and huckleberries are highly perishable and should be offered for sale as quickly as possible. In refrigerated cases, they may be displayed satisfactorily at temperatures of 32° to 50° F. but will keep better at temperatures below 40°. If daytime refrigeration is not available and it is necessary to keep berries another day, they should be held at night in a room the temperature of which is 32° to 40° and the relative humidity 85 to 90 percent.

Berries should not be sprinkled.

Broccoli (Italian or sprouting)

Italian or sprouting broccoli is highly perishable and while it may be displayed for 2 or 3 days at temperatures of 40° to 50° F., temperatures of 32° to 35° are even better. At temperatures above 55°, broccoli ages rapidly, the buds turn yellow or brown, and early stages of decay soon appear. Without refrigeration, only 1 day's shelf life can be expected because of wilting and yellowing. If daytime refrigeration is not available, refrigeration at night should be furnished.

Broccoli should be garnished with ice or, at low temperatures, sprinkled with water to minimize wilting, yellowing, or other discoloration, and weight losses. Light sprinkling is more desirable than heavy wetting, especially at high temperatures when excessively wet produce is more

likely to decay. If the broccoli is not refrigerated during the day or night, sprinkling is not recommended because of the danger of decay, with consequent off-odors.

Reserve supplies keep best if covered with crushed ice, but some deterioration may occur under any method of storage. A relative humidity of 90 to 95 percent is desirable.

Brussels sprouts

Brussels sprouts are highly perishable and should be sold quickly. Temperatures as low as 32° F. and high humidity (90 to 95 percent) are desirable. Low temperatures retard the development of yellow leaves and decay. Brussels sprouts need not be sprinkled with water unless wilting appears, and then only at low temperatures.

Cabbage

Refrigeration in retail stores is desirable if display space is available. Sprinkling with water aids in preventing wilting and drying of the outer leaves and results in a more attractive appearance of the heads.

Reserve supplies of cabbage keep best when refrigerated; temperatures of 50° F. or lower and a relative humidity of 90 to 95 percent are beneficial.

Carrots

Carrots have a longer shelf life if prepackaged than if displayed in bulk, because the highly perishable tops have been removed and the roots are protected in moisture-retentive bags. Bunched carrots are still displayed in some stores, especially during the marketing of locally grown stock. Both prepackaged and bulk carrots need refrigeration for best results. The latter may require lower temperatures to minimize decay and yellowing or other discoloration of the leaves.

Variation in the condition in which bunched carrots are received at the retail store may cause wide differences in results obtained on the display racks. The principal defects are yellow and discolored (brownish) leaves and flabby, discolored, and shriveled roots. These defects develop rapidly in carrots that are not sprinkled and are held at high temperatures. Sprinkling with water at low temperatures prolongs the shelf life by preserving a fresh appearance of the leaves and firmness of the roots. Light sprinkling will give better results than heavy wetting, which may cause dark, watersoaked areas on the leaves. If daytime refrigeration is not available, night refrigeration should be furnished. When carrots are displayed in an ice-bed case, garnishing with ice or lightly sprinkling with water several times daily will prolong their shelf life.

Reserve supplies of carrots will keep for several days at temperatures of 32° to 50° F. A relative humidity of 90 to 95 percent is desirable for bunched carrots. Crushed ice spread over bunched carrots reduces the temperature and provides satisfactory moisture conditions.

Cauliflower

The principal defects of cauliflower that may develop in the retail store are spotted discoloration and flabbiness of the curds and wilting and yellowing of the leaves. Spreading and loose formation of the curds indicate aging, which may be slowed down by low temperatures and high humidity.

Cauliflower should be kept as cool as possible; temperatures as low as 32° F. are desirable. Cauliflower in good condition may be displayed satisfactorily for 2 or 3 days at temperatures of 32° to 50°. Sprinkling with water or garnishing with crushed ice reduces weight losses and lessens wilting of the leaves and flabbiness of the curds. When the average temperature of the cauliflower is above 50°, however, sprinkling sometimes results in spotting of the curds. Cauliflower that has been displayed on nonrefrigerated racks during the day should be refrigerated at night.

Reserve supplies should be stored at 32° to 40° F. and at a humidity of 85 to 90 percent.

Celery

Display temperatures of 50° F. or lower and sprinkling with water several times daily will keep celery in good condition for several days. Celery displayed without refrigeration during the day should be refrigerated at night.

Reserve supplies of celery should be stored at about 32° to 35° F. if possible. Crushed ice spread over the celery will provide desirable low temperatures and ideal moisture conditions. A relative humidity of 90 to 95 percent is desirable.

Cherries

Cherries are highly perishable and benefit from display temperatures of 40° to 50° F. If cherries are held too long after removal from storage—especially if they are wet from sweating—brown rot and gray, blue, or green mold rots may develop. Cherries should not be sprinkled.

Reserve stocks may be held for a few days at low temperature, preferably 32° F., at a relative humidity of 85 to 90 percent.

Collards

Collards can be expected to keep in satisfactory condition for a few days at temperatures as high as 50° F. If displayed without refrigeration during the day, they should be sprinkled with water or garnished with ice during the day and refrigerated at night. Crushed ice spread over reserve supplies will keep them cool and provide beneficial moisture. A relative humidity of 90 to 95 percent is desirable.

Corn, Sweet

Sugar content largely determines the quality of sweet corn. It decreases rapidly at ordinary room temperatures but decreases more slowly at a temperature of 32° F. Sweet corn heats rapidly unless it is well refrigerated; it should be kept at the lowest possible temperature above freezing. If sweet corn is not sold during the first day on display, it should be refrigerated at night. A light layer of crushed ice spread over the corn during the day and a heavy layer at night will help to reduce the temperature and provide desirable moisture.

Cranberries

During cool seasons, cranberries may be displayed without refrigeration for several days, but temperatures of 36° to 50° F. are always beneficial. Temperatures below 36° are harmful. If cranberries are held below 36° for over 2 or 3 weeks, "low-temperature breakdown," marked by a rubbery texture, develops.

Cucumbers

Cucumbers should be displayed at temperatures at 40° to 50° F. If they are held more than a few days at temperatures below 40°, surface pitting or dark, watery areas appear. Such areas soon become infected, and the affected cucumbers decay rapidly on removal to warmer temperatures. Sprinkling with water has no material advantage but is not harmful.

Reserve supplies should be held at about 45° F. and a relative humidity of 85 to 95 percent.

Dates

Dates ordinarily stand up fairly well for several days at room temperatures. However, the lower the temperature below 50° F. the better their keeping quality. Temperatures as low as zero do not harm dates but are actually beneficial to them. Dates readily absorb moisture and odors from the air. The rate of absorption is much less at temperatures below 32° than at those above 32°. Deterioration caused by humidity above 75 percent is slow at temperatures below 28°. If dates gain excessive moisture they become more perishable, and if they lose excessive moisture they become too dry for consumer acceptance.

Eggplant

The best conditions for eggplant are temperatures between 40° and 50° F. and a relative humidity of 85 to 90 percent. Surface pitting and bronzing frequently occur on eggplants held continuously at temperatures below 40°. Unsightly indentations and a fading of the purple color may result from direct contact with ice. Eggplants lose moisture and become soft and wrinkled if displayed continuously for several days without

refrigeration. When daytime refrigeration is not available, egg plants should be stored overnight at temperatures of about 40° to 45°. Sprinkling with water is beneficial.

Endive

Curly endive and broad-leaved escarole, like lettuce, should be well refrigerated to prevent heating and to retard the development of decay. Temperatures of 32° to 35° F. are most desirable, but temperatures of 40° to 50° will prove beneficial for several days. At these temperatures, light sprinkling with water will minimize wilting and give the produce an attractive appearance. When endive is stored overnight in a refrigerated room, a relative humidity of 90 to 95 percent is desirable.

Figs, Fresh

The best temperature for fresh figs is 32° F. Temperatures up to 45° are reasonably satisfactory for a few days. Alternaria spotting, which may start while figs are on the trees and may continue to develop after harvest especially around 50°, greatly detracts from the appearance of the fruit. Reserve stocks should be kept to a minimum. Best holding conditions are 31° to 32° and a relative humidity of 85 to 90 percent.

Grapefruit

Grapefruit in good condition may be displayed for 4 or 5 days at room temperatures without significant loss of quality. For short storage periods, grapefruit can be held satisfactorily at temperatures ranging from 32° to 60° F. and a relative humidity of 85 to 90 percent. Sprinkling with water gives no material advantage but is not harmful during short display periods.

Grapes

The European, or vinifera, grapes are benefited by temperatures between 30° and 50° F., and a relative humidity of 85 to 90 percent. Low humidity results in shriveling, especially of the stems. Although the stems may become dry, and sometimes may become brittle when held or displayed in a dry atmosphere, the risk of increasing mold and decay is too great to justify sprinkling with water.

Reserve supplies may be held satisfactorily for a few days at 30° to 40° F.

Kale

Both prepackaged and bulk kale should be refrigerated. Display temperatures of 40° to 50° F. will give reasonably good results, but temperatures below this range to a minimum of 32°, are preferable. Bulk kale should be lightly sprinkled with water or garnished with ice to preserve freshness. Reserve supplies are best held at temperatures of 32° to 40° and a relative humidity of 90 to 95 percent.

Leeks, Green

Green leeks are best held at 32° to 40° F., but they may be displayed for about 2 days at 40° to 50°. Sprinkling with water at low temperatures or garnishing with crushed ice aids in the prevention of wilting and drying, but at high temperatures the application of water may result in the development of slimy decay.

Reserve stocks keep best under a covering of crushed ice in a refrigerated storage room. A relative humidity of 90 to 95 percent is desirable.

Lemons

Lemons will retain a fresh, attractive appearance for about 10 days at temperatures of 32° to 50° F. Overnight storage at 32° to 50° is recommended. Reserve supplies to be held under constant conditions longer than 10 days or so are best kept at temperatures of 50° to 55°. If lemons are displayed continuously at room temperatures for a week or more, frequently they become excessively soft or their skins become dry and ridged. As the loss of moisture continues the fruit may also shrink in size.

Sprinkling with water several times daily has no harmful effect, and it often aids in preventing shriveling and weight losses, even in lemons displayed at room temperatures.

Lettuce

Lettuce will decay rapidly unless well refrigerated. Temperatures of 32° to 35° F. are most desirable, but even those of 40° to 50° will retard the development of decay for 2 or 3 days. If displayed in a mechanically refrigerated case, or if held overnight in a cold room after daytime display without refrigeration, lettuce should be lightly sprinkled several times daily to prevent wilting or withering. If displayed in an ice-bed case, it should be garnished with ice or sprinkled with water several times during the day and covered with a heavy layer of ice when prepared for night storage. Lettuce displayed on a nonrefrigerated rack should be held at low temperatures at night. Sprinkling of nonrefrigerated lettuce should be kept to a minimum.

Wrapping individual heads of lettuce in film not only aids in the retention of moisture but also prevents loss of outer leaves caused by frequent customer handling.

Limes, Tahiti (Persian)

Limes are subject to pitting when held at temperatures below 45° F. The best display temperatures are between 45° and 50°. Holding for a few hours at temperatures between 45° and 40° will cause no harm. The fruit gradually yellows at room temperatures. Sprinkling with tapwater is not harmful and is sometimes beneficial. In storage, a relative humidity of 85 to 90 percent is desirable.

Mangoes

Mangoes may be stored satisfactorily at temperatures of 55° to 75° F. Internal discoloration of the flesh may develop in storage at temperatures below 55°, but temperatures of about 45° to 50° will retard decay and softening of full-ripe fruit.

Melons

Cantaloups, honeydew, Casaba, Crenshaw, and Persian melons usually need no refrigeration while on display in retail stores. If full ripe, however, they are held best at temperatures of about 45° F. Surplus unripe melons are best held at 55° or higher; otherwise they may fail to ripen satisfactorily. If melons are stored too long or at too low temperatures, breakdown or decay develops so rapidly on removal to room temperatures that they soon become worthless. Important defects are softening of bruised areas, decay, surface breakdown, and off-flavors.

Except for convenience to the customer, watermelons need no refrigeration during display in retail stores. They may be held in storage for 2 or 3 weeks at temperatures of 36° to 40° F. and a relative humidity of 85 to 90 percent. At 32°, decay will not develop so rapidly but after 1 week the watermelons may become pitted or dented and take on an objectionable flavor.

Mushrooms, Cultivated

Mushrooms should be displayed under refrigeration, for best results. Freshly picked mushrooms will keep in prime condition for 3 to 5 days at 32° F., for 1 or 2 days at 40°, and for only 1 day at 50°.

Nectarines

Unripe nectarines are best displayed without refrigeration. Ripe nectarines, however, should either be displayed continuously in refrigerated cases or be stored in refrigerated fruit and vegetable storage rooms at night after daytime display without refrigeration. Reserve supplies of nectarines may be held satisfactorily for several days at temperatures of 32° to 45° F. and a relative humidity of 85 to 90 percent. The lower the holding temperature, the longer the nectarines may be displayed in retail stores.

Okra

Okra does best at temperatures of about 50° F. At temperatures below 40° it may show surface discoloration, pitting, and decay after removal to room temperatures. In 3 days, at 70° some of the pods will be decayed or shriveled, but at 32° nearly all the pods will be severely pitted. Contact or top ice has caused waterlogging in 3 days at all temperatures. Sprinkling is not generally advisable, but a relative humidity of 85 to 95 percent in storage will minimize wilting.

Onions, Dry

Dry or cured onions need not be refrigerated during short display or storage periods. They should be kept dry, because high humidity induces root growth and decay. A humidity of 70 to 75 percent is desirable.

Reserve supplies of dry onions should not be refrigerated in retail stores, as dampness from sweating on removal to room temperatures will encourage mold growth. Since sprouting is a problem at high temperatures, excessive supplies should be avoided.

Onions, Green

Green onions and green shallots are highly perishable, even when displayed in refrigerated cases, and should be marketed as quickly as possible. High temperatures accelerate and low temperatures retard the development of yellow and decayed leaves. Green onions and shallots should be kept at temperatures as low as 32° F., if available equipment permits, during both day and night. Onions and shallots that have been displayed during the daytime on nonrefrigerated racks should be refrigerated at night. At high temperatures, sprinkling with water minimizes wilting but may result in more slimy decay than in onions not sprinkled. As decay is much more serious than wilting, sprinkling at high temperatures should be held to a minimum or eliminated entirely. Sprinkling at low temperatures preserves a fresh, crisp, attractive appearance. Crushed ice spread over the onions and shallots during display and in storage will aid in keeping them cool and supply moisture to lessen wilting.

Oranges

Oranges received in good condition at the retail store may be held for 4 or 5 days at room temperatures without material deterioration. However, refrigeration is always beneficial. Oranges that show signs of withering or decay should be held under refrigeration at low temperatures or quickly marketed; if daytime refrigeration is not available, the oranges should be removed to cold rooms at night. Moisture from condensation or sprinkling with tapwater may slightly reduce moisture loss and will have no harmful effect upon the condition of the fruit.

Reserve supplies should be held at temperatures between 32° and 50° F. in a relative humidity of 85 to 90 percent.

Parsnips

Parsnips may be displayed for a few days without refrigeration, but temperatures below 50° F., together with sprinkling with water, are beneficial. Reserve supplies of parsnips may be held at temperatures of 32° to about 45°. A relative humidity of 90 to 95 percent in the storage room is desirable to minimize wilting.

Peaches

As refrigeration retards ripening, peaches that have not yet ripened sufficiently should be displayed without refrigeration. On the other hand, to keep ripe peaches in the best condition, they should either be displayed in a refrigerated case or stored in a fruit and vegetable storage room at night after daytime display in nonrefrigerated cases. Weight losses and losses from decay are greatest in peaches displayed without refrigeration. Tests have shown that moisture condensation caused by changes in temperature from refrigerated storage to room temperature displays had no harmful effect.

Reserve supplies of peaches may be held satisfactorily for a few days at temperatures of 32° to 45° F. and in a relative humidity of 85 to 90 percent.

Pears

The best ripening temperature for pears is about 60° to 70° F.; they usually do not soften but will soon decay at temperatures as high as 75° to 80°. Pears that have been conditioned (that is, brought to a stage so they will be ripe enough to eat in a day or so) may be displayed to advantage at temperatures of 40° to 50°.

Reserve supplies of conditioned pears should be held at temperatures of about 40° to 45° F. in a relative humidity of 90 to 95 percent.

Sprinkling with water is not advisable because it sometimes results in watersoaking of the flesh at skinbreaks. Physical handling of pears should be kept to a minimum, and excessive handling discouraged. Moving pears from display racks to and from refrigerated night storage rooms often results in scratches and bruises that become badly discolored when the pears are displayed at room temperatures.

Peas, Green

Green peas are highly perishable and should be sold quickly if desirable quality is to be offered and excessive losses avoided. Refrigerated peas are more attractive and taste better than nonrefrigerated peas. Unless held at 32° F., part of their sugar content is lost. Green peas lose quality rapidly at temperatures above 45°. At low temperatures, light sprinkling with water or garnishing with crushed ice will delay excessive withering or drying of the pods. Peas displayed without refrigeration during the daytime should be refrigerated at night. When held overnight in cold rooms, the spreading of ice over the peas is beneficial. Shelled peas are even more perishable than the unshelled.

Peppers, Green

Green peppers are subject to chilling injury when held continuously at temperatures below 45° F. The surface of the peppers may become pitted and the calyx discolored after removal to higher temperatures.

However, temperatures of 40° to 50° are satisfactory for peppers for the short period they are held in retail stores. At these temperatures, peppers may be lightly sprinkled with water to prevent wilting and loss of weight. At high temperatures, sprinkling increases decay; without sprinkling, peppers lose weight and become flabby. Red color develops rather rapidly at temperatures above 50°.

Reserve supplies may be held for a few days at 40° to 50° F. with a relative humidity of 85 to 90 percent.

"Weak" peppers, even under the best handling practices, may show excessive deterioration after only a short display period. Because of the difficulty of recognizing weak peppers, especially without knowledge of the previous history of growing, handling, transportation, storage, and other conditions, retailers should market peppers as soon as possible to minimize losses.

Persimmons

Persimmons will ripen in a few days at a temperature of 55° F. or higher. The best temperatures to delay ripening or to hold ripe persimmons are about 30° to 32°. A relative humidity of 85 to 90 percent is desirable.

Pineapples

Full-ripe pineapples can be held satisfactorily at 40° to 45° F.; mature-green fruits should not be displayed at temperatures below 50°, as some of these retain part of the green color in the skin and fail to develop good flavor in the flesh after removal to room temperatures. The relative humidity for pineapples should be about 85 to 90 percent.

Plums (including prunes)

Display temperatures of 40° to 50° F. are beneficial, but plums and fresh prunes may be displayed at higher temperatures for a day or so. Decay, shriveling, and internal browning are the main condition defects of plums and prunes.

Reserve supplies are benefited by temperatures as low as 31° F. in a relative humidity of 85 to 90 percent.

Potatoes

Potatoes can be displayed and reserve supplies satisfactorily stored without refrigeration in retail stores. They should not be displayed in bright sunlight; even display-case or other store lighting may cause greening of the potatoes after exposure for several days. Reserve stocks of early-crop potatoes can be held at 50° F. if space is available. Early-crop potatoes are more perishable than late crop.

Pumpkins and Squashes

Pumpkins and hard-shell squashes can be displayed and reserve supplies held satisfactorily without refrigeration. Temperatures below 50° F. may cause cold injury that is often followed by decay.

Summer squash—yellow crookneck, straight ("banana"), and other soft-skin types—may be displayed at temperatures of 35° to 50° F. Sprinkling with water minimizes drying and reduces weight losses. Reserve supplies may be held satisfactorily at temperatures of 35° to 45° in a humidity of 90 to 95 percent.

Yellow summer squash often becomes badly discolored from frequent handling. Extreme care and minimum handling will lessen unsightly discoloration of yellow summer squash displayed in retail stores.

Radishes

Radish roots are commonly prepackaged in film bags. Removal of the leafy tops reduces decay, and the film bag aids in the retention of moisture in the roots. Radishes with tops are still found in some retail stores, especially during the marketing of locally grown stock. Both prepackaged and bulk radishes should be refrigerated to preserve satisfactory quality.

Bunched radishes, one of the most highly perishable commodities displayed in retail stores, should be quickly sold. Temperatures of 32° to 35° F. are most desirable, but display at 45° to 50° for a day or so will retard the development of decay and yellowing of the leaves. At temperatures above 50°, decay progresses more or less rapidly, depending upon the condition of the radishes when received at the store. Decay often starts where the tissue has been injured by tie-strings. Radishes that have been displayed during the daytime on nonrefrigerated racks should be refrigerated at night. Garnishing bunched radishes with crushed ice prolongs their shelf life by providing moisture as well as lowering temperatures. Radishes may be sprinkled lightly to lessen yellowing and wilting of the leaves and flabbiness of the roots.

Reserve supplies of bunched radishes keep best at 32° to 40° F. with a relative humidity of 90 to 95 percent. Crushed ice spread over the radishes during storage will provide desirable moisture and low temperatures.

Raspberries

See Berries.

Rhubarb

Temperatures of 32° to 50° F. and a relative humidity of 90 to 95 percent are beneficial to rhubarb. If space is available, rhubarb should be displayed in an ice-bed case or on mechanically refrigerated racks and garnished with ice or sprinkeld with water to prevent heating and drying. Rhubarb displayed without refrigeration during the daytime should be refrigerated at night.

Reserve supplies should be stored at temperatures of 32° to 40° F. Rhubarb should be loosely packed to allow good circulation of air; otherwise there is danger of heating and mold growth.

Shallots

See Onions, Green.

Spinach

Prepackaged and bulk spinach should be kept as cool as available refrigeration will permit without freezing. Temperatures as low as 32° F. are most desirable but for a relatively short display period spinach will usually keep satisfactorily for 1 or 2 days at temperatures as high as 50°. A relative humidity of 90 to 95 percent is desirable.

At low temperatures, sprinkling with water or garnishing with ice will help keep bulk spinach crisp and fresh in appearance. At high temperatures, spinach will become wilted if not sprinkled or garnished, and yet, if sprinkled, it is more likely to decay. Spinach should be arranged loosely on display racks to allow good air circulation. If displayed without refrigeration during the daytime, spinach should be refrigerated at night. Garnishing with crushed ice will aid in preserving crispness and minimize yellowing and the development of decay. When iced produce barrels are used, bulk spinach should be placed in cloth bags to facilitate handling.

Squashes

See Pumpkins and Squashes.

Strawberries

See Berries.

Sweetpotatoes

Sweetpotatoes should not be refrigerated in retail stores. Temperatures below 55° F. should be avoided because of possible chilling injury or damage from certain types of decay, which may develop in the injured tissue soon after removal to higher temperatures. Noncured sweetpotatoes are more susceptible to cold injury than cured ones. The general symptoms of cold injury are increased decay, pitting, and internal discoloration which may show up before or after cooking. Sweetpotatoes should be handled as little and as carefully as possible to avoid skinbreaks, through which decay organisms can enter and quickly cause decay.

Tangerines

Temperatures of 32° to 50° F. and high humidity are very beneficial in maintaining the quality of tangerines. Low temperatures reduce decay greatly and aid in the retention of the natural flavor. Sprinkling with water several times daily minimizes drying. When daytime refrigeration is not available, tangerines should be stored at night in cold rooms.

Reserve stocks of tangerines should be stored at 32° to 40° F. in a relative humidity of 90 to 95 percent.

Tomatoes

The holding temperatures for tomatoes in retail stores depends on the rate at which tomatoes are sold, the stage of ripeness preferred by the customers, and the stage of ripeness of the stock on hand. If the demand is mostly for fully colored tomatoes and they are delivered at the store below this stage of ripeness, a majority of the stock should be ripened before they are offered for sale.

Mature-green tomatoes ripen best at temperatures of 60° to 70° F. At temperatures below 55° tomatoes develop poor color when ripe, and have a tendency to decay. At 55° they ripen slowly; at 70° they may be ripened rather rapidly for immediate demand, but a temperature range of 60° to 65° is preferable and is used most often by the tomato-ripening industry. At this range, ripening is slower than at 70° or above, but the fruit is firmer when ripe and there is usually less loss from decay. Displaying ripe tomatoes at 40° to 50° may delay aging and breakdown.

Reserve supplies of unripe tomatoes should be held at temperatures of about 55° to 70° F.

Turnips and Rutabagas

Bunched turnips are not so perishable as bunched beets or bunched carrots; the tops are less tender and the roots less subject to drying. Temperatures of 32° to 50° F. will give satisfactory results for several days, and sprinkling with water will aid in keeping the tops fresh, green, and attractive, and the roots firm. Topped turnips may be displayed without refrigeration for 2 or 3 days, but storage in coolers at night is helpful in retaining good quality and condition.

Rutabagas are very hardy and are displayed without refrigeration in retail stores. Sprinkling with water has no advantage as they are usually coated with a heavy application of wax.

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