Protection of PAPER-PACKAGED FRUITS AND VEGETABLES Displayed on Ice

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PROTECTION OF PAPER-PACKAGED FRUITS AND VEGETABLES DISPLAYED ON ICE

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SUMMARY

Paper packages of fresh produce placed directly on ice often become unsalable due to absorbed water, thereby adding to marketing costs for these products. This study was made to determine what the retailer could do to eliminate the cost and the inconvenience of repackaging such merchandise. The study included tests on 15 kinds of ice covers to learn whether any of them would prevent water damage to packages displayed and yet would allow adequate refrigeration of the produce.

The data showed that polyethylene sheeting, except for its tendency to creep forward on the ice, was the most satisfactory of the covers tested. It practically eliminated water damage to the packages, it caused a rise of only 4° F. over the temperature of packages displayed on kraft paper, it could be cleaned and reused repeatedly, and it was inexpensive.

The average temperature of 38.5° F., obtained within packages placed on the polyethylene cover, indicated that such a cover should provide a relatively safe display temperature for certain types of fresh fruits and vegetables that should not be displayed directly in contact with ice because of the danger of chilling.

Experimental evidence indicates that a 2-mil polyethylene ice cover should provide a method for the safe display on ice of absorbent paper packages, bags, trays and cartons of cranberries, gooseberries, strawberries, currants, blueberries, dewberries, grapes, cherries, ripe tomatoes, mushrooms, and small iris and lily bulbs.

INTRODUCTION

The safe display of paper bags, trays, and cartons of fresh produce often presents a problem to the retailer whose store does not have mechanical refrigeration. His alternatives are to display the packages without refrigeration, or to display them on a bed of crushed ice. Without refrigeration, the retailer suffers the consequences of rapid deterioration of the quality of his produce. If he uses crushed ice, water damage to the packages may make his merchandise unsalable.[1]

A preliminary study showed that chipboard boxes placed directly on ice for 24 hours may absorb water equal to one-sixth of their tare weights, and become so wet that the packages come apart when handled (fig. 1). To study this problem further, replicate comparisons were made at the Plant Industry Station at Beltsville, Md., of several kinds of ice covers to determine whether the water absorbed by paper packages could be limited without serious loss of refrigeration. The studies are part of a broad program of continuing research designed to reduce the cost of marketing farm products.

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[1] United States Department of Agriculture. Buyer Preference for Cranberry Packaging in Boston and Topeka. Bur. Agr. Econ. & Farm Credit Admin., Mktg. Res. Rpt. No. 34, p. 11. Washington, D. C. May 1953.

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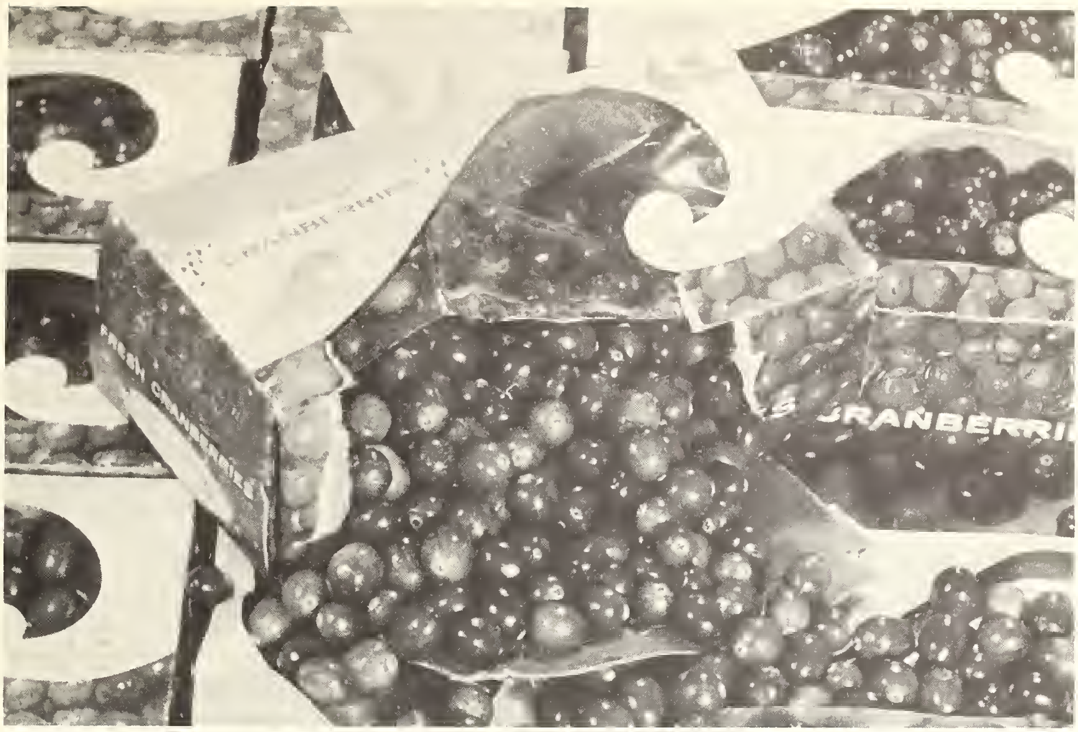

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Figure 1. A wet package that has come apart with handling. Lost sales and increased waste often result from such damage.

MATERIALS AND METHODS

Massachusetts-grown Late Howes cranberries were the test produce. Approximately 454 grams of berries were weighed into each of 49 one-pound chipboard window boxes for each set of tests. The boxes were placed 1 package high over the surface of a retail ice-bed case. The case was kept supplied with crushed ice to a depth of 4 or 5 inches. Various covers were placed over the ice bed, and the packages were placed upon these covers.

The produce supplied merely a test weight for each package. The window box used in the experiments was a type readily available that provided a means of measuring the effects of different ice covers. This box is typical of a great many in commercial use.

Initial studies included comparison of various protective covers as follows: different thicknesses of paper, 2 and 3 sheets of kraft paper, white wrapping paper, heavy wax paper, kraft paper coated with polyethylene, kraft paper plus a superimposed wire-mesh screen or cloth, kraft paper plus a perforated metal sheet, polyethylene sheeting plus a perforated metal plate, corrugated galvanized iron sheet, flat galvanized iron sheet, aluminum foil, a corrugated iron sheet plus kraft paper, and thin polyethylene sheeting. Scores were given to these covers based on comparative costs; durability and reuse; ease of sanitary maintenance of the covers; the tendencies of the materials, and of the packages upon them, to slip about or creep over the surface of the ice bed; absorption or adsorption of water from the ice and from the atmosphere; and relative thermal conductivities. These initial tests and scores were largely subjective in nature, but they afforded a rapid basis of selecting covers that would merit further testing.

The cover materials used in the experiments here reported had the following specifications: (A) 0.005-inch kraft wrapping paper; (B) 0.010-inch kraft paper with a polyethylene coating on one side; (C) 0.002-inch (2-mil) polyethylene sheeting; (D) 18-gauge galvanized iron wire screen, 1/2-inch mesh; (E) 20-gauge iron perforated sheet with 1/2-inch perforations staggered on 3/4-inch centers; and (F) 26-gauge galvanized iron sheet with 1/4-inch corrugations. These materials were used as covers either alone or in various combinations.

These materials as ice covers to protect paper packages were evaluated by three types of tests: (1) water absorbed by packages placed upon the covers, as measured by the increase in tare weight; (2) water damage to the packages, based on their appearance at the end of the test period; and (3) relative thermal conductivities of the covers, measured by temperatures within the packages. Tare weights were rounded to the nearest gram. Temperatures were rounded to the nearest 0.1° F. All data were mathematically tested for significance.[2]

Thermocouples for temperature measurements were taped in place inside the packages against the bottom surfaces. The corresponding temperatures for these 20 thermocouples were automatically recorded by an electronic potentiometer. The temperature of the display room where the tests were conducted was maintained at 70° to 75° F. The relative humidity varied from 40 to 50 percent and was not regulated or maintained. A continuous record of the ambient conditions was obtained by a hygrothermograph.

Figure 2 shows packages with different degrees of water damage. For tests of significance, the different degrees of damage also were given numerical scores.

All test periods were for a display time of 72 hours each.

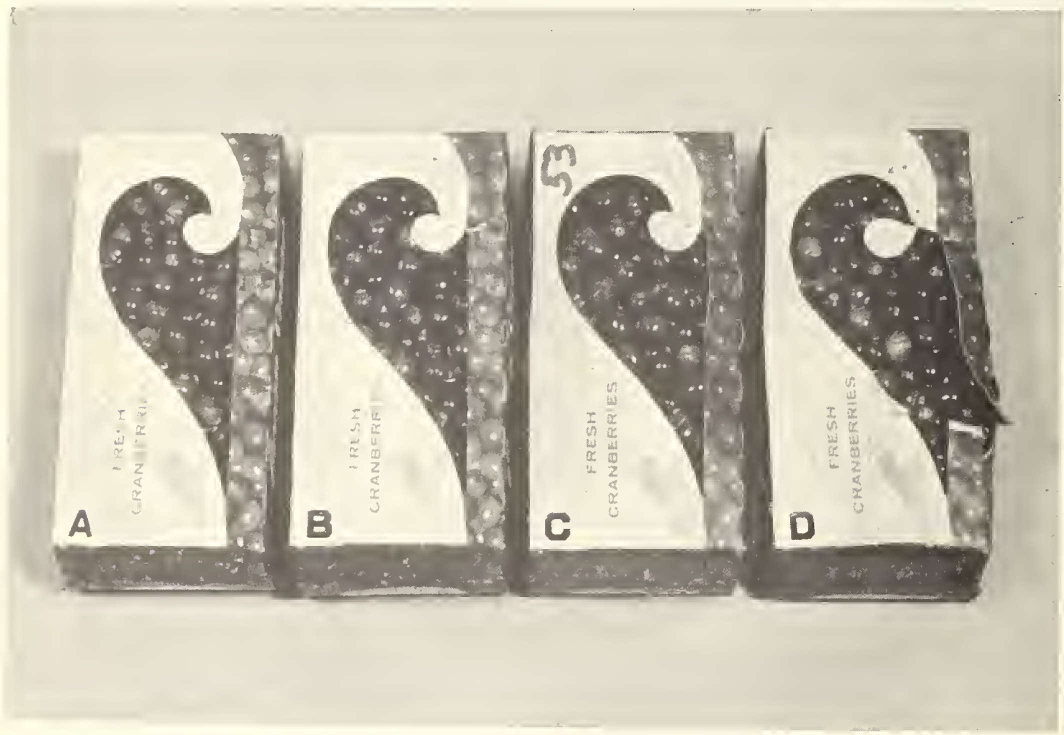

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Figure 2. Different amounts of water damage that may occur to packages within 72 hours on various ice covers. Grades are identified as follows: (A) good = undamaged; (B) fair = slight damage, but salable; (C) poor = damaged, but salable at a discount; (D) very poor = damaged, completely water-soaked and unsalable without repackaging.

[2] Two levels of significance were used. "Odds of 19 to 1" means that, on the basis of given data, observed comparisons probably will be true 95 times in 100. Similarly, "odds of 99 to 1" means that the observed comparisons probably will be true 99 times in 100.

RESULTS AND DISCUSSION

When either type of metal cover was used alone, the thermal conductivity of the perforated plate, of the corrugated sheet, and of the wire-mesh screen allowed rapid cooling of the package surfaces. However, atmospheric moisture condensed readily on the metals. This moisture, plus the ice water that came up through the open areas or over edges of the ice covers, caused packages displayed on such covers to become wet more rapidly than packages displayed on other types of covers. Metal covers used alone provided the best refrigeration, but provided the poorest protection against water damage.

Kraft paper used alone as an ice cover provided less rapid cooling of packages than metal covers did; but for about 24 hours it provided better protection against water damage. After 24 hours, kraft paper covers became water soaked and packages on them were in no better condition than they would have been on metal covers.

It appeared that although neither a metal cover nor a kraft paper cover would be satisfactory when used alone, if used together their advantages might be complementary. This was found to be true when four types of combination covers were tested against a cover of kraft paper alone. The results of this test are given in table 1.

Table 1.--Comparison of various ice covers using kraft paper as the initial cover on the ice

Type of cover	Specifications of cover[1]	Average grams of water absorbed per package	Average appearance of packages[2]
Kraft paper alone.........	A	[3] 32.2	Poor
Kraft paper plus perforated metal sheet..................	A + E	8.6	Fair +
Kraft paper plus wire-mesh screen........	A + D	4.3	Good -
Kraft paper plus corrugated iron sheet..................	A + F	2.6	Good
Kraft paper plus polyethylene-coated kraft (polyethylene side down).............	A + B	5.0	Good -

[1] Specifications of these materials are given in the text under Materials and Methods.
[2] These ratings were based on numerical scores assigned to types of damage. These types are illustrated in figure 2.
[3] The difference between this average and the others was significant by odds of 99 to 1.

Mathematical analysis of the data summarized in table 1 showed that the average amount of water absorbed by packages displayed on kraft paper alone was much higher than that of packages displayed on other types of covers. There was no significant difference among the other 4 covers in amounts of water absorbed.

Preliminary tests indicated that polyethylene sheeting might be as good as the best cover given in table 1. Further tests were made comparing polyethylene with other types of covers. The results of these tests are given in table 2.

Table 2.--Comparison of various ice covers with polyethylene sheeting as the initial cover on the ice

Type of cover	Specifications of cover[1]	Average grams of water absorbed per package[2]	Average appearance of packages[3]
Polyethylene sheet alone..................	C	2.7	Good -
Polyethylene sheet plus perforated iron sheet.............	C + E	2.3	Good
Polyethylene sheet plus wire-mesh screen.................	C + D	2.7	Good
Polyethylene sheet plus corrugated iron sheet.............	C + F	2.7	Good -
Polyethylene sheet plus uncoated kraft paper............	C + A	2.3	Good
Polyethylene sheet plus polyethylene-coated kraft paper (polyethylene side down)..................	C + B	2.3	Good
Polyethylene sheet plus polyethylene-coated kraft paper (polyethylene side up)....................	C + B	3.4	Good -

[1] Specifications of these materials are given in the text under Materials and Methods.
[2] These averages were not significantly different from each other at odds of 19 to 1.
[3] These ratings were based on numerical scores assigned to types of damage. These types are illustrated in figure 2.

The data of table 2 showed no significant difference in water damage to packages displayed on any of the covers. The packages were only slightly discolored, and customers probably would have rejected none of them. It appeared probable that protection to the packages was due to the polyethylene sheeting rather than to any combination of polyethylene and the other covers.

This contrast in results to those obtained with a kraft paper cover suggested a comparison of kraft paper alone with polyethylene sheeting alone. When this comparison was made, the average amount of water absorbed per package displayed on the polyethylene was 3.24±0.36 grams, and the average appearance of the packages was good. The average amount of water absorbed per package displayed on kraft paper was 44.09±3.00 grams, and the average appearance of these packages was very poor. The amounts of water absorbed per package, under the two methods of display, were significantly different from each other at odds greater than 99 to 1. The performance of the polyethylene ice cover was superior to that of the kraft paper cover in both evaluation scores.

Figure 3 shows the packages at the completion of the tests. At the end of 72 hours, the appearance of 81 percent of the packages on polyethylene was good and the other 19 percent showed only slight damage. In contrast, 90.5 percent of the merchandise displayed on the kraft paper ice cover would have been unsalable without repackaging the produce or offering it as damaged merchandise at a reduced price.

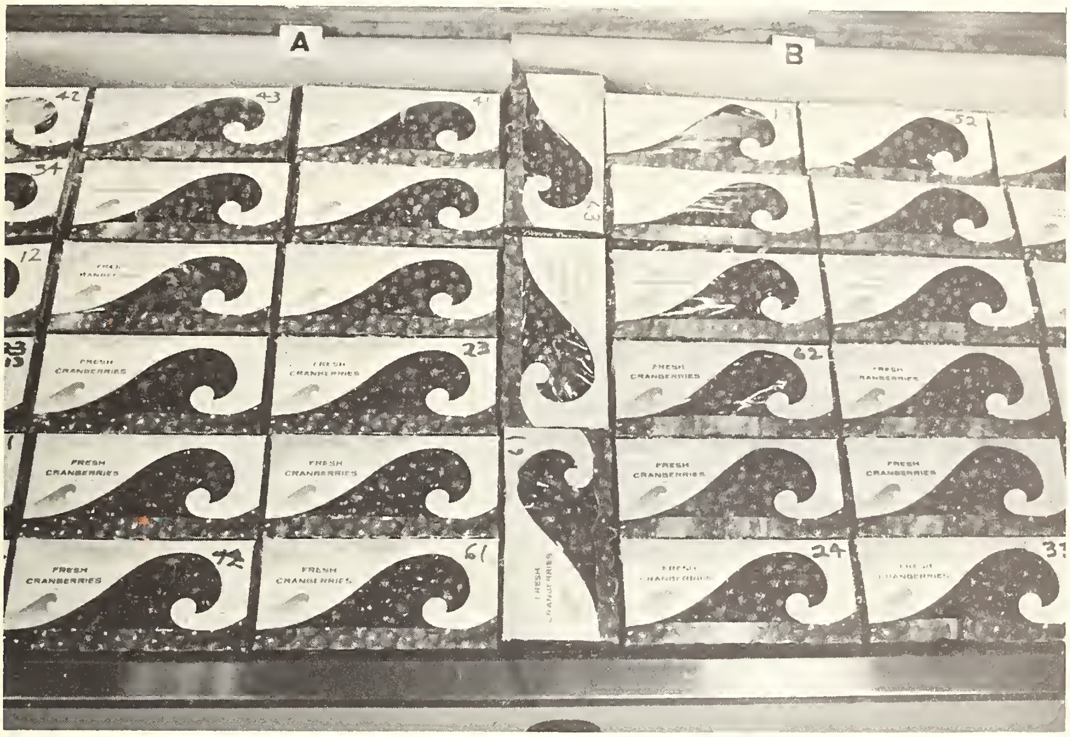

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Figure 3. Polyethylene and kraft paper ice covers under test. The packages on the left, marked A, were on ice covered by a 2-mil sheet of polyethylene. The packages on the right, marked B, were on ice covered by heavy kraft paper. All B packages at the end of the test showed water marks and discoloration, while the A packages showed little or no damage.

Although temperatures were recorded to indicate the probable refrigeration obtainable on each type of cover, only those temperatures recorded for the last set of comparisons are of immediate interest. The average temperatures found were 38.5±0.2° F. in the packages on polyethylene and 34.7±0.1° F. in the packages on kraft ice covers. The difference of 3.8±0.2 higher temperature on the polyethylene cover was highly significant (odds greater than 99:1).

A polyethylene ice cover is much more desirable for display of paper-packaged produce than a kraft ice cover is, even though temperatures over the kraft cover were slightly lower.

Polyethylene sheeting stayed in position on the ice bed as long as packages covered its entire surface; however, if some packages were removed, the remaining packages and the cover tended to creep forward over the ice bed. This disadvantage could be removed by clipping the cover to the back wall of the case, or by attaching the cover to a top rail or to a weight.

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