**CIHM
Microfiche
Series
(Monographs)**

**ICMH
Collection de
microfiches
(monographies)**

Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1997

Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming are checked below.

- ☐ Coloured covers / Couverture de couleur
- ☐ Covers damaged / Couverture endommagée
- ☐ Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- ☐ Cover title missing / Le titre de couverture manque
- ☐ Coloured maps / Cartes géographiques en couleur
- ☐ Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- ☐ Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- ☐ Bound with other material / Relié avec d'autres documents
- ☐ Only edition available / Seule édition disponible
- ☐ Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.
- ☐ Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from filming / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- ☐ Additional comments / Commentaires supplémentaires:

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- ☐ Coloured pages / Pages de couleur
- ☐ Pages damaged / Pages endommagées
- ☐ Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- ☒ Pages discoloured, stained or foxed / Pages décolorées, tachetées ou piquées
- ☐ Pages detached / Pages détachées
- ☒ Showthrough / Transparence
- ☐ Quality of print varies / Qualité inégale de l'impression
- ☐ Includes supplementary material / Comprend du matériel supplémentaire
- ☐ Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image / Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.
- ☐ Opposing pages with varying colouration or discolourations are filmed twice to ensure the best possible image / Les pages s'opposant ayant des colorations variables ou des décolorations sont filmées deux fois afin d'obtenir la meilleure image possible.

This item is filmed at the reduction ratio checked below /
Ce document est filmé au taux de réduction indiqué ci-dessous.

10x	14x	18x	22x	26x	30x
☐	☐	☐	☐	☒	☐
12x	16x	20x	24x	28x	32x

The copy filmed here has been reproduced thanks to the generosity of:

Library
Agriculture Canada

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche sheet contains the symbol $\rightarrow$ (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:

L'exemplaire filmé fut reproduit grâce à la générosité de:

Bibliothèque
Agriculture Canada

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole $\rightarrow$ signifie "À SUIVRE", le symbole ∇ signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)

APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482-0300 - Phone
(716) 288-5989 - Fax

DEPARTMENT OF AGRICULTURE
DAIRY AND COLD STORAGE COMMISSIONER'S BRANCH
OTTAWA - CANADA

**THE RATE OF PRECOOLING FRUIT IN DIFFERENT
STYLES OF PACKAGES AND AT
DIFFERENT TEMPERATURES**

BY

EDWIN SMITH, B.S.A.,

AND

J. M. CREELMAN, B.S.A.

BULLETIN No. 51
DAIRY AND COLD STORAGE SERIES

Published by Direction of the Hon. Martin Burrell, Minister
of Agriculture, Ottawa.

FEBRUARY, 1917

18270—1

LETTER OF TRANSMITTAL.

To the Honourable

The Minister of Agriculture.

SIR,—I beg to submit for your approval a report of some investigations carried on at the Grimsby Precooling and Experimental Fruit Warehouse to determine the rate at which fruit can be cooled in different styles of packages and at different temperatures. The information should be useful to fruit growers and others engaged in the shipping of fruit.

I have the honour to recommend that this report be published as Bulletin No. 51 of the Dairy and Cold Storage Series.

I have the honour to be, sir,

Your obedient servant,

J. A. RUDDICK,

Dairy and Cold Storage Commissioner.

OTTAWA, ONT., February 3, 1917.

RATE OF PRECOOLING FRUIT.

INTRODUCTION.

In establishing precooling plants, there has been need of more information concerning the rate of cooling in the centres of the different packages of various kinds of fruit when exposed to a cooling air of a given temperature. The tests discussed herein were made with this end in view.

There has also been need of reliable information regarding behaviour of summer fruits when precooled quickly in four or five hours' time, using a temperature below freezing to do the work, as compared with the behaviour of fruit cooled slowly over a period of eighteen or twenty-four hours.

In making these tests the given variety and type of package of fruit has commonly been divided into four lots, one-half of which were stored at 40° F., or a refrigerator car temperature, and half at 32° F. One lot in each temperature was cooled rapidly at a temperature lower than 25° F., while the other lot was cooled gradually, using a temperature of 40°, for several hours. In rapid precooling the fruit was removed from the low temperatures as soon as the interior of the package was cooled to a temperature between 32° and 40° F., so that no freezing took place.

In securing the records of the rate of cooling, extension mercurial recording thermometers were used, having the sensitive bulb in the centre of the packages tested.

In studying these records and applying them to commercial conditions, it is well to consider the fact that they were made with the temperature of the air surrounding the package constant or very nearly constant during the entire period of cooling. Under commercial conditions, unless a large reserve of refrigeration is on hand, and is controlled automatically, the temperature of the cooling air is bound to be higher when the fruit is warm at the start of cooling than it will be after cooling has progressed.

RESULTS

In stating results averages will be given showing wastage after a long storage period, so as to make comparisons:—

STRAWBERRIES.

	Low Temperatures used, 20° F.	
	Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 6 days at 32° F... ..	9.0	0.0
Held 6 days at 40° F... ..	9.0	12.7

No injury was apparent from the rapid cooling and although the averages show the rapidly cooled to be superior, no practical difference could be seen in making inspections.

CHERRIES—SWEET.

	Low Temperatures used, 12° F. and 15° F. Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 14 days at 32° F.	0.0	0.0
Held 14 days at 40° F.	6.93	6.55

With the Napoleon Biggareau variety a slight injury was apparent from using 32° F., so slight as to be negligible. Otherwise, no difference could be seen between the two methods.

CHERRIES—SOUR.

	Low Temperatures used, 17° F. and 20° F. Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 10 days at 32° F.	6.67	5.41
Held 10 days at 40° F.	10.01	12.73

No injury was to be seen from rapid cooling.

RASPBERRIES.

	Low Temperatures used, 20° F. Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 6 days at 32° F.	0.0	0.0
Held 6 days at 40° F.	2.68	1.90

Averages of wastage favour slow cooling. The amount of difference, if any, could be seen in the general appearance of the fruit.

PLUMS.

	Low Temperatures used, 15° F. and 20° F. Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 20 days at 32° F.	2.55	1.96
Held 20 days at 40° F.	6.97	7.36

No injury was apparent from rapid cooling.

PEACHES.

	Low Temperatures used, 15° F. and 20° F. Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 20 days at 32° F.	0.0	0.84
Held 20 days at 40° F.	0.32	1.07

No injury was apparent from rapid cooling.

TOMATOES.

	Low Temperatures used, 15° F. Average Percentage of Waste.	
	Cooled Rapidly.	Cooled Slowly.
Held 20 days at 32° F.	0.0	16.88
Held 20 days at 40° F.	18.57	14.26

Low temperatures are not satisfactory with tomatoes. Tests thus far with tomatoes have not been conclusive in arriving at the best temperatures for precooling or storage. Temperatures slightly below 32° F. may be safely used if precooling is stopped as soon as the tomatoes reach a temperature of 38° F.

TIME REQUIRED FOR PRECOOLING.

In order to show the necessary time required to lower the temperature of the interior of different packages of fruit, the following charts have been prepared from recording thermometer records, the fruit being at different temperatures when placed for cooling and being subjected to different air temperatures while cooling.

Diagram 1.— Showing length of time required to cool Strawberries in 24 pint and 1 quart Crates.

Diagram 2.—Showing length of time required to cool Cherries in 6 quart and 11 quart Baskets.

Diagram 3.—Showing rate of cooling of Raspberries in 24½ quart Orates.

Diagram 4. —Showing rate of cooling of Plums in 11 quart Baskets.

Diagram 5. — Showing length of time required to cool Plums in 6 quart and 11 quart Baskets.

Diagram 6.—Showing rate of cooling of wrapped Peaches in Boxes.

Diagram 7. - Showing length of time required to cool Pears in 11 quart Baskets.

Diagram 8.—Showing rate of cooling of Apples in the centre of the Barrel.

CONCLUSIONS.

Tender fruits such as raspberries, cherries, plums and peaches may be precooled in a short time without injury to the fruit using temperatures as low as 15° F., providing the fruit is removed from the low temperature before its temperature reaches the freezing point.

With strawberries, tomatoes, cucumbers and cantaloupes extremely low temperatures should be used with caution, although it is safe to use temperatures lower than 32° F., providing cooling is stopped when the temperature of the fruit reaches 38° F.

With the exception of the fruits mentioned, there is no danger of injury from low temperatures unless freezing actually takes place. Freezing will not take place for some time after the temperature of the fruit reaches 32° F. Even when using a cooling temperature of 15° F., the temperature of the fruit will not reach this point for several hours.

By using an air temperature of 15° most basket fruits will cool from 75° F. to 40° F. in four hours.

By using an air temperature of 32° F. most basket fruits will cool from 75° F. to 40° F. in ten hours.

By using an air temperature of 38° most basket fruits will cool from 75° F. to 40° F. in eighteen hours.

For the purpose of efficiency, precooling plants should be designed to do their work rapidly. The warehouse type of plant should be designed to precool fruit from 85° F. to 40° F. in not more than ten hours' time. Fruit being received in the afternoon may thus be shipped the following forenoon, clearing out the rooms for the afternoon's receipt of warm fruit and increasing labour efficiency by using men in the afternoon for receiving.

Rapid cooling shortens the time of despatch of the shipment, not only the extra time needed for slow cooling, but often as much as twenty-four hours where long-distance freight trains are made up but once daily.

BULLETINS OF THE DAIRY AND COLD STORAGE SERIES RELATING TO THE STORAGE AND SHIPMENT OF FRUIT.

No.	Date.	Title.
27	1911	Trial Shipments of Peaches, 1910.
44	1915	The Cold Storage of Food Products.
47	1916	The Grimsby Precooling and Experimental Fruit Storage Warehouse.
48	1916	Precooling, Shipment and Cold Storage of Tender Fruit.
50	1917	The use of Brine Tank Refrigerator Cars for the shipment of Fruit.
51	1917	The Rate of Precooling, etc.
52	1917	Methods of Handling Basket Fruits.
Circular.		
15	1916	Cherry Cooling Possibilities.