Cold storage of apples.

H. C. Price
Iowa State College

Follow this and additional works at: http://lib.dr.iastate.edu/bulletin

Part of the Agriculture Commons, and the Fruit Science Commons

Recommended Citation
Available at: http://lib.dr.iastate.edu/bulletin/vol7/iss72/1

This Article is brought to you for free and open access by the Extension and Experiment Station Publications at Iowa State University Digital Repository. It has been accepted for inclusion in Bulletin by an authorized editor of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
COLD STORAGE OF APPLES
Board of Trustees

Ex-officio:
A. B. Cummins, Governor of Iowa.
Hon. R. C. Barrett, Supt. of Public Instruction.

Term Expires

First District—Hon. S. H. Watkins Libertyville 1904
Second District—Hon. C. S. Barclay, West Liberty 1904
Third District—Hon. E. A. Alexander, Clarion 1908
Fourth District—Hon. C. L. Gabrilsen, New Hampton 1904
Fifth District—Hon. W. R. Moninger, Galvin 1906
Sixth District—Hon. W. O. McElroy, Newton 1908
Seventh District—Hon. W. K. Boardman, Nevada 1906
Eighth District—Hon. W. B. Penick, Tingley 1904
Ninth District—Hon. J. H. Wilson, Adair 1908
Tenth District—Hon. J. B. Hungerford, Carroll 1906
Eleventh District—Hon. W. J. Dixon, Sac City 1906

Officers of the Board

Hon. J. B. Hungerford, Carroll, Chairman.
Prof. E. W. Stanton, Ames, Secretary.
Herman Knapp, Ames, Treasurer.

Station Staff

A. B. Storms, President.
C. F. Curtis, B. S. A., M. S. A., Director.
W. J. Kennedy, B. S. A., Animal Husbandry and Vice-Director.
A. T. Erwin, Asst. Horticulturist.
J. B. Weems, Ph. D., Chemist.
H. E. Summers, B. S. Entomologist.
Carl W. Gay, V. M. D., Veterinarian.
G. L. McKay, Dairying.
C. J. Zintheo, B. Sc., Farm Mechanics.
W. J. Rutherford, B. S. A., Assistant in Animal Husbandry.
F. W. Bouska, B. S. A., Dairy Bacteriology.
C. Larsen, B. S. A., Assistant in Dairying.
R. E. Buchanan, Assistant in Botany.
E. E. Little, B. S. A., M. S. A., Assistant in Horticulture.
E. C. Myers, Assistant Chemist.
Charlotte M. King, Artist.

http://lib.dr.iastate.edu/bulletin/vol7/iss72/1
COLD STORAGE OF APPLES.
BY H. C. PRICE.

CONTENTS.

I. General Survey.
   1. Introduction.
   2. Status of Apple growing in the state.
   3. Importance of Cold Storage to the state.

II. Handling the Apple Crop.
   1. Harvesting for storage
   2. Packing for storage.
   3. Methods of storing.
   4. Cost of storage.
   5. Temperature for storing.

III. Test of Keeping Qualities of Standard Varieties.
    1. The experiment.
    2. Notes on varieties tested.
    3. Conclusions.
GENERAL SURVEY.

1. INTRODUCTORY.

Iowa has an abundance of hardy and productive varieties of summer and fall apples, but there are really no satisfactory varieties of late keeping winter apples that can be grown in the northern part of the state. The varieties that are hardy are inferior in quality, size and productiveness. The hardy foreign varieties that have been introduced are of short season, and will not keep longer than the 1st of December. As a consequence of this condition, the people must either do without winter apples, buy eastern grown apples or depend upon keeping the apples that they can grow by cold storage. In order to determine the practicability of cold storage for keeping fall and winter varieties of apples, an experiment was made last fall to determine the keeping qualities of standard varieties that are grown in the state.

2. STATUS OF APPLE GROWING IN IOWA.

The census of 1890 shows that there were growing in the state 3,140,588 trees and the production of 1889 was 5,540,352 bushels in 1900 the number of trees had risen to 6,869,588 and the production of 1899 was 3,129,862 bushels.

An examination of the map showing the distribution of the apple trees in the state in 1900 will show that the southwestern portions of the state are the important apple growing sections. A more careful examination would further show that the apple growing districts follow the banks of the rivers and that all the counties bordering on the Missouri, have large numbers of apple trees as far north as Woodbury County and the plantings are extensive bordering the Des Moines river as far north as Boone County.

The quality of apples produced in these districts is the finest and the counties bordering on the Chicago, Burlington and Quincy R. R. have become famous for their production of apples.

The handling of this crop to the greatest advantage is of vital importance to the growers and in many sections of the southwestern part of the state the apple crop furnishes the principal income. The apples in these sections of the state are bought at harvest time either on the tree or picked and delivered to the packer. They are sorted, graded and packed and shipped to storage houses or placed upon the
Price: Cold storage of apples.
market at once. The prices at which they are bought depend upon the crop. If the prospects are for a very large crop the prices are correspondingly low and in such cases it often happens that storing the apples for a month or two, will carry them over the temporary glut of the market and prices will advance very rapidly and large profits can be secured from storing. This was not the case however, in 1902. The amount of apples stored was greater than estimated, the quality of the crop as a whole was low, necessitating its marketing earlier than usual and the prices were depressed and in some cases as low the first of January as at the time of harvesting. This however was an exceptional season and may not occur again for many years.

3. THE IMPORTANCE OF COLD STORAGE OF APPLES TO THE STATE.

Commercial apple growing is rapidly increasing in the state as shown by the comparison of the census of 1890 and 1900. But as mentioned in the introduction, few late varieties will do well in the state and as a consequence, the market season of Iowa apples is comparatively short and the bulk of the crop has to be marketed during November and December. This causes an over supply of apples at this time and consequently large quantities are shipped out of the state in order to find a market. After the first of January, the Iowa apples commence to disappear rapidly, and Eastern apples take their place. There are no statistics available of the amount of apples that are shipped into the state, but if they could be had they would be astounding.

If ample cold storage houses could be found in all of the cities of the state and private houses by the largest fruit growers or fruit growing associations, the market season would be prolonged until May 1, to practically the exclusion of the Eastern apples, and the distribution would be equalized so as to avoid the glut of the market which so often occurs the first part of the winter.

The Eastern apples are not the equal in quality of the Iowa Jonathans, Winesaps, Grimes' Golden, and Domine and with adequate facilities of cold storage for our home apples, could not compete with them. At present the facilities of the state are almost nothing. The best statistics available are those of H. Rich & Co., of Chicago, publishers of Ice and Refrigeration, who in their statistics of cold stor-
age houses of the country, only report eight in Iowa. Clarinda is reported as having one, Davenport, one; Des Moines, two; Waterloo, one; Fort Madison, two and Chariton, one.

If apples can be successfully held in cold storage there is a good demand for them until the 1st of June. After this the spring vegetables and early fruits replace them and there would be little call for them if they were held. But if apples could be furnished throughout the winter at a reasonable cost, the consumption would be doubled and the entire supply could come from Iowa orchards.

II. HANDLING THE APPLE CROP.

1. HARVESTING FOR STORAGE.

No conclusive experiments have yet been made to determine the best time for harvesting apples for storing but results seem to indicate that an immature or overripe apple does not keep as well as one that has just reached maturity. In harvesting Wealthy and Fameuse apples, for example, they should be gathered when they have attained their full size and are well colored, but before there is any breaking down of the flesh, or mealiness evident, but the flesh should be firm and crisp. Storing of the fruit before it is quite mature will tend to cause it to shrivel and injure its flavor and it does not resist decay as well as though picked later.

2. PACKING FOR STORING.

It will only pay to keep the best selected apples in cold storage. It costs just as much storage on poor apples as it does on good ones and the poor apples will only hurt the sale of the better ones, and the probability is that they will be the first to decay and will induce decay in the good apples. Storing never improves the fruit, it simply preserves it. Wormy and scabby apples will never be changed to perfect specimens by storing. The culls and second class apples had better be disposed of as soon as harvested and the selects carefully packed and if of the varieties that have proven to be good keepers, sent to the storage room as quickly as possible after picking.

Some experimental work has been done to determine the best method of packing, and recently a ventilated barrel has given good results but as yet it has not passed the experimental stage. Some experiments have also been made.
in storing in bulk instead of packing in barrels but such a practice is only practicable for home storing, on account of the difficulty of handling the fruit in bulk when shipped.

A number of experiments * have also been made of the practicability of wrapping the fruit in paper before storing. It is found that the wrapping prolongs the time which they may be kept to a great extent.

But from a commercial standpoint it is impracticable since the increase in the price that can be obtained for them will not pay for the additional labor involved.

For exhibition purposes, this is the only practical way of keeping them, and each apple should be wrapped in a sheet of parafine paper and this again wrapped in a sheet of newspaper, and by this method and proper refrigeration, most varieties may be held 12 to 18 months successfully.

3. METHODS OF STORING.

There are but two methods of commercial storing that are of importance: First, ice cold storage; second, mechanical cold storage. The ice cold storage is practical for the grower who wishes to store his fruit on his own premises and has an abundance of ice that can be easily harvested.

The storage room should be built in connection with the ice house so that the room may be kept cooled by permitting the air to circulate over the ice. The expense of such a house is not great and the cost of operating is practically nothing after the ice is harvested. It has the advantage of being close at hand, the apples can be placed in it as soon as picked, and they need not be packed at once as would be the case if they were being shipped to a storage house. Often at the time of harvesting and packing the apple crop there comes a period of very warm weather and the apples are in poor condition before they reach the cold storage houses in the cities.

On the other hand, the city storage has the advantage of having the apples on the market all the time. Prospective buyers can inspect them at any time and they do not need to be moved by the owner when selling them. In a city storage that makes a business of storing apples, a more uniform temperature and better ventilation can be had than in the home ice storage house. The home storage however, has the fruit where the owner can watch it closely and dis-

*Bulletin 93, N. H. Agricultural Experiment Station.
cover at once any change in its condition.

Mechanical refrigeration, although the ideal method, is not practical for the grower to put in, simply to store his crop of apples since, the cost of machinery is too great to permit it to lie idle except during the time it is needed for the apple crop. If it can be used for other purposes throughout the year it will be found to be the most ideal way of furnishing refrigeration.

4. COST OF STORAGE.

The cost of storing apples in cities varies from 10 to 12 ½ cents per barrel per month and from 40 to 50 cents per barrel for the season which extends from the time they are put in storage in October or November, until the 1st of May, when the season is supposed to close. Where storing is done in a private house the cost will vary with the amount of capital invested in the house, the cost of harvesting the ice used in it, and other incidental expenses. Fifty cents per barrel may be taken however, as a fair estimate of the actual cost for storing until the 1st of May. To this however must be added the shrinkage from decay and the cost of repacking if the apples are kept until late in the spring. Apples should advance at least $1.00 per barrel over the cost at time of storing to make it profitable to hold them until the end of the storing season. However, it must be remembered that far the largest part of the crop will be disposed of within three months after storing, and without repacking, so that a considerable less advance in price would warrant a grower in storing his crop.

5. TEMPERATURE FOR STORING.

Experiments have proven that a lower temperature than at first used by commercial houses is the more desirable for apples. The temperature that has proven to be the most satisfactory in 33 degrees Fahr. and in our experiment was the temperature we tried to keep. How well we succeeded is shown by the temperature charts. Lowering the temperature does not stop all changes going on in the apple but simply delays them. Fruit can not be kept indefinitely at 32 degrees Fahr. freezing, without any changes. There are chemical changes going on which result in what we call over ripeness, mealiness, and loss of flavor. This change is independent of decay and is hindered by low temperature and hastened by high.
In experiments* made by the New Hampshire Experiment Station, these changes were found to be at first a change of starch to cane sugar and then the change of cane sugar to invert sugar and finally a decrease in the total amount of sugar. Also a decrease at the same time in the acid in the fruit. The keeping of the apples does not therefore depend entirely on the preventing of decay from fungi, but also on the retarding of these chemical changes. These may go on and do go on at 32 degrees Fahr. but very slowly and the rate at which they progress varies in the different fruits and in different varieties. The loss of flavor and the length of time that fruit will keep after removing from storage depends upon the chemical changes that have taken place while in storage. Since these changes in the apple are retarded by low temperature, it is probable that the nearer the fruit may be held to 32 degrees Fahr. the better.

**TEST OF KEEPING QUALITIES OF STANDARD VARIETIES.**

1. THE EXPERIMENT.

In order to test the keeping qualities of standard varieties of apples generally grown in the state, an experiment was instituted in the fall of 1902 by the Horticultural Department of the Iowa Experiment Station. The apples were stored in the Des Moines Ice and Cold Storage warehouse. A self registering clock thermometer was kept in the storage room from the middle of November until the experiment was closed April 15. The readings of this thermometer are shown on the accompanying chart and the variations in the temperature of the room from Nov. 15 until April 15 with the exception of four weeks for which time records were lost.

The object of the experiment was two fold—first, to determine the relative keeping qualities of the varieties stored, and second, to determine the length of time it would be practical to hold the different varieties in storage.

The test was commenced the 20th of Sept. when 15 barrels consisting of 4 bbls. Wealthy, 4 bbls. Fameuse, 5 bbls. Wolf River, and 2 bbls. McMahon’s White, were placed in storage. They were raised by Mr. C. O. Garrett.

*Bulletin 93, N. H. Ex. Sta.*
of Mitchellville, Polk Co., and where taken as the representatives of the fall varieties.

On Oct. 29th 72 barrels consisting of 10 bbls. Jonathan, 10 bbls Domine, 10 bbls. Seek-No-Further, 10 bbls. Ben Davis, 8 bbls. Willow Twig, 6 bbls. Janets, 5 bbls. Red Romanite, 5 bbls. Roman Stem, 4 bbls. Northern Spy, 4 bbls White Pippin. They were grown in Adam's County and were packed at Corning, Iowa, by S. W. Morris under the direction of a representative of the Experiment Station. They were well graded and were a fair sample of well packed commercial apples.

In order to determine the keeping qualities of the varieties a portion of the lot stored was withdrawn each month, commencing the 14th of January. The apples withdrawn were counted and those that showed any signs of decay were recorded as decayed and the balance as sound. Each lot was sold after examination. The test was carried on until April 14th, when all apples in storage were disposed of, as the service, as shown by temperature charts, was not as good as it had been and the purpose of the experiment had been carried out. On a commercial basis it is seldom desirable to hold apples after the middle of April or 1st of May as they come in competition with tropical fruits and small fruits at that time.

The results of the examinations are given in the following tables, with the percentages of the decay in each variety:

**JANUARY 14, 1903.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>No. Decayed</th>
<th>No. Sound.</th>
<th>% Decayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wealthy (1 bbl.)</td>
<td>12</td>
<td>350</td>
<td>3</td>
</tr>
<tr>
<td>McMahon (2 bbls.)</td>
<td>335</td>
<td>655</td>
<td>51</td>
</tr>
<tr>
<td>Fameuse &quot; &quot;</td>
<td>54</td>
<td>1070</td>
<td>4</td>
</tr>
<tr>
<td>Wolf River &quot; &quot;</td>
<td>80</td>
<td>520</td>
<td>13</td>
</tr>
<tr>
<td>Jonathan &quot; &quot;</td>
<td>85</td>
<td>770</td>
<td>9</td>
</tr>
<tr>
<td>Domine &quot; &quot;</td>
<td>27</td>
<td>770</td>
<td>3</td>
</tr>
<tr>
<td>Seek-No-Further (2 bbls.)</td>
<td>105</td>
<td>900</td>
<td>10</td>
</tr>
<tr>
<td>Ben Davis (2 bbls.)</td>
<td>4</td>
<td>604</td>
<td>Less than 1</td>
</tr>
<tr>
<td>Janet (1 bbl.)</td>
<td>25</td>
<td>725</td>
<td>3</td>
</tr>
<tr>
<td>Roman Stem &quot; &quot;</td>
<td>75</td>
<td>507</td>
<td>12</td>
</tr>
<tr>
<td>Northern Spy &quot; &quot;</td>
<td>50</td>
<td>375</td>
<td>11</td>
</tr>
<tr>
<td>White Pippin &quot; &quot;</td>
<td>18</td>
<td>223</td>
<td>7</td>
</tr>
</tbody>
</table>

**FEBRUARY 14, 1903.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>No. Decayed.</th>
<th>No. Sound.</th>
<th>% Decayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wealthy (1 bbl.)</td>
<td>16</td>
<td>346</td>
<td>4</td>
</tr>
<tr>
<td>Fameuse &quot; &quot;</td>
<td>11</td>
<td>642</td>
<td>1</td>
</tr>
<tr>
<td>Wolf River (2 bbls.)</td>
<td>154</td>
<td>270</td>
<td>36</td>
</tr>
<tr>
<td>Seek-No-Further (4 bbls.)</td>
<td>825</td>
<td>865</td>
<td>48</td>
</tr>
</tbody>
</table>
MARCH 14, 1903.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wealthy (1 bbl.)</td>
<td>50</td>
<td>275</td>
<td>15</td>
</tr>
<tr>
<td>Fameuse (1 bbl.)</td>
<td>75</td>
<td>531</td>
<td>12</td>
</tr>
<tr>
<td>Ben Davis (5 bbls.)</td>
<td>289</td>
<td>2122</td>
<td>11</td>
</tr>
<tr>
<td>Domine (4 bbls.)</td>
<td>319</td>
<td>1641</td>
<td>16</td>
</tr>
<tr>
<td>Janet (2 bbls.)</td>
<td>109</td>
<td>1150</td>
<td>8</td>
</tr>
<tr>
<td>Romanite (1 bbl.)</td>
<td>25</td>
<td>676</td>
<td>3</td>
</tr>
<tr>
<td>Roman Stem (1 bbl.)</td>
<td>176</td>
<td>253</td>
<td>41</td>
</tr>
<tr>
<td>Pewaukee (4 bbls.)</td>
<td>1020</td>
<td>787</td>
<td>56</td>
</tr>
<tr>
<td>Willow Twig (4 bbls.)</td>
<td>104</td>
<td>1448</td>
<td>6</td>
</tr>
<tr>
<td>White Pippin (2 bbls.)</td>
<td>158</td>
<td>272</td>
<td>36</td>
</tr>
</tbody>
</table>

APRIL 14, 1903.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Domine (4 bbls.)</td>
<td>271</td>
<td>1607</td>
<td>14</td>
</tr>
<tr>
<td>Ben Davis (5 bbls.)</td>
<td>456</td>
<td>1814</td>
<td>18</td>
</tr>
<tr>
<td>Willow Twig (1 bbl.)</td>
<td>75</td>
<td>308</td>
<td>19</td>
</tr>
<tr>
<td>Jonathan (1 bbl.)</td>
<td>109</td>
<td>356</td>
<td>23</td>
</tr>
<tr>
<td>Seek-No-Further (4 bbls.)</td>
<td>1113</td>
<td>815</td>
<td>57</td>
</tr>
<tr>
<td>Romanite (1 bbl.)</td>
<td>198</td>
<td>798</td>
<td>24</td>
</tr>
</tbody>
</table>

2. NOTES ON VARIETIES IN STORAGE.

**Ben Davis:** The keeping qualities of this variety are too well known to need comment; it can be readily kept throughout the entire season. It was included in the test as a basis of comparison for the other varieties.

**Domine or Wells:** The keeping qualities of this old variety in storage is equal to any of the winter varieties. Its quality is excellent and its season could easily be made to extend until May 1st.

**Fameuse:** This variety can undoubtedly be kept profitably until March 1st, if properly picked and packed in the fall. There was no appreciable loss in quality, and the keeping was equal to that of the winter varieties until March 1st.

**Janet:** Keeping quality equal to Ben Davis. Will keep throughout the winter in cellars or caves, and was used in test as basis of comparison. Too small to store commercially.

**Jonathan:** The results with the Jonathan, I do not re-
gard as conclusive and I believe may be very much improved by a more careful selection of fruit and more careful packing.

The season of the variety is undoubtedly much longer than of the Wealthy or Fameuse, for it will be seen by the tables that the percentage decayed in one barrel on April 14 that had not been touched since storing, October 29th, was no more than the average of four barrels on February 14th. With proper care the variety could undoubtedly be held until April 1st.

**McMahon's White:** This large showy apple is not suited to storing as shown by the tables. It is subject to "scalding" and decays badly.

**Northern Spy:** By mistake, but two barrels of Northern Spy were included in the test and these were examined and removed when the January records were taken and did not give promising results.

**Pewaukee:** By mistake four barrels of Pewaukees were substituted for Northern Spys and were not discovered until the March examination, when all were examined and removed and at that time showed over 50 percent. decayed. It is not suitable for storing.

**Roman Stem:** The variety did not give results that would indicate that it would be profitable to store. Being a white apple it showed a tendency to "scald" and did not keep satisfactorily after the 1st of January.

**Romanite or Red Romanite:** Like the Ben Davis and Janet, will keep all winter in cellar storage and was used as a basis of comparison for other varieties. The apples are so small in size that it would not pay to store them.

**Seek-No-Further:** Though in quality about the equal of the Domine and would seem to possess equal keeping qualities, yet in the test, the results were very different. On January 14th, it showed 10 percent decayed sufficient to require repacking and "plugging" before selling. Not suitable for storing.

**Wealthy:** As already noted, the most surprising results were obtained in the keeping qualities of this variety. From our test it seems that it could be easily held until March 1st. Samples examined by prominent horticulturists of the state during January and February were pronounced to be equal in quality to any Wealthies they ever ate. In the markets on account of color and quality they will sell with the Jonathan and Winesap. After March 1st they became "mealy" and

http://lib.dr.iastate.edu/bulletin/vol7/iss72/1
were past the point where it would be profitable to store them.

White Pippin: The apples of this variety were of exceptional quality when stored and the specimens were of unusual size. They did not stand storing well and went down very quickly when taken out.

Willow Twig: A very late keeping variety of excellent quality and like Ben Davis, is suitable for storing to supply the April and May trade.

Wolf River: This variety like McMahon's White, is unsuitable for storing. The apples showed a tendency to crack open and the quality which at best is low was very much injured by storing.

3. CONCLUSIONS.

Although the experiment has been too brief for final conclusions to be drawn and the work will probably be duplicated another year, yet it has brought out certain results that are suggestive and valuable.

The wonderful adaptability of the Wealthy and Fameuse apples to cold storage purposes will mean thousands of dollars to the orchardists of the state if taken advantage of. The Wealthy is hardy throughout the state, is productive, is of excellent quality, and its only drawback is its keeping quality. But apples of this variety stored on Sept. 20th, showed 97 percent sound on Jan. 14th and on Feb. 14th, 96 percent sound. The Fameuse kept equally well.

The results show just as conclusively also that some varieties are not adapted to cold storage and it is just as important for the orchardist to know what not to store as it is to know what to store. The McMahon and Wolf River, stored at the same time as the Wealthy and Fameuse showed decayed on Jan. 14th, 51 percent and 13 percent respectively.

In some varieties of the winter apples also, the results have been just as conclusive. The Seek-No-Further showed 48 percent decayed on Feb. 14 and the White Pippin, 30 percent. Other varieties showed such large percentages of decayed fruit in March, that it evidently would not be well to hold them later than March 1st. The Domine, which is an old variety grown quite largely in the southern half of the state showed keeping qualities equal to Ben Davis and Wil-
low Twig and in fact in the April examination, showed a smaller percentage of decay than either of them.

Cold storage will equalize the distribution of the apple crop and lengthen its season so that the orchards of the state may supply and increase the consumption of the same.