

Cold Storage
for
Fruit and Vegetables.

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Outline.

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Introduction.

It is less than a hundred years ago since men found ice valuable enough as a preservative to be shipped to Southern lands. In deed, the uses of ice were very few, and it was not until about the middle of this century that men discovered its many possibilities. At present, it may be said that nearly every inhabitant of this country gets some benefit either directly or indirectly from the many uses of ice.

It is estimated that at present there is a capital of from forty to fifty millions of dollars invested in this industry. The idea of storage for fruit and vegetables, as well as other products, is a natural outgrowth of our improved methods of production or an outgrowth of the so-called "overproduction" if there be such an evil. Storage was brought about by:- first, overstocked markets, which are of short duration, second, short

seasons that certain fruits, as peaches, can endure; and, third, entire crop failure. Experiments have proven beyond all doubt, that cold storage will entirely eliminate all these evils in many cases, and at least, partially, in all cases. At present, it may be said that with the experiments and experience of others to guide him, it is possible for every well established farmer to successfully operate a cold storage house, be it large or small. Here he can keep his fruit, vegetables, meat, butter, eggs and ice throughout the entire year. In Kansas, all the above named products are plentiful, even including the ice. In this way, the producer gets the direct benefit of his labors; but when he sends to a cold storage plant in a large city, he generally does not get such direct benefit. Nor can he sort his fruit from time to time. He cannot even personally sell his products, but must

submit to some commission merchant who like a drone gets the benefit. Where, however, large quantities of fruit are to be stored, it is an advantage to have it near some large market on account of the fact that fruit and vegetables cannot be kept long after coming from the cold storage, and therefore must be sold at once. Again a large cold storage plant is usually better equipped for the regulation of temperature and moisture than the ordinary farmer can well hope to be.

Principles of Cold Storage.

All success in cold storage depends upon the circulation of dry, cold, fresh air at a uniform temperature. This has made the great cold storage plants, built on scientific principles as they are, of such value for preserving fruit, meats and the various other products.

As is known, cold air is heavier than warm air and if the two are brought together or mixed, the former will sink forcing the latter up. If now the ice be placed above some objects to be cooled, the air coming in contact with the ice will fall and as it strikes the warm objects it will be warmed and will be forced upward again only to be again cooled and returned. Thus a complete circulation is set up, but this would readily be broken if air were allowed to come in from all directions. So in practice it is found that the entire building, except a place for ventilation in the roof, must be air-tight that is, there must be absolutely no cracks or drafts thru the drain pipe below. Thus it is seen that if the ice were kept below and the products above, there would be no circulation, the cold air would remain near the ice.

For these reasons, it is necessary to have the source of cold above as is done in all cases of cold storage from the great plants of our large cities down to the simplest refrigerator in our kitchen.

Usually where ice is used in a storage plant, the building is a two-story structure having the ice in the second story while the products are below. The two rooms are connected with flues or chutes thru which the air passes from above downward and vice versa. In order to keep up this circulation between these two rooms, it is necessary, as before stated, to avoid currents thru the drain pipe which ~~must~~ be guarded with traps. If there is not much water to be carried off and the subsoil is loose, an ordinary sink hole will answer.

In building and operating refrigerator cars, these principles must also be applied. The ice is either stored above the ceiling in the car or at the ends but in either case the car must be constructed as carefully as a refrigerator room.

Machinery for Making Artificial Ice.

There are in successful operation several distinct kinds of ice machines. In a general way, they may be classed as follows.

1. Compression system.
2. Air system.
3. Absorption or Ammonia system.

Of these we will now give more of the details.

Professor Trompeter of New Haven, Conn. patented the first ice machine in the United States in 1833. His machine was the first one of the compression system. It had a capacity of

one ton per day. This system uses ammonia as does also the absorption system but in the former the principle upon which it works is that when a gas is compressed, heat is given off and when the gas is again released heat is taken up from the surrounding objects. This liberation of gas takes place in pipes. If now, water surrounds the pipes, it is evident that it too will be cooled and this water is then conducted into the cold room thru more pipes. As a matter of fact, pure water will not answer because the liberated gas lowers the temperature of the water to considerable below the freezing point. Thus ice would be formed. Fortunately, however, all liquids do not freeze at that temperature, and it is known that brine freezes only at a considerable lower temperature, so that brine is used in the pipes.

After the gas has thus been liberated into the pipes, it is again carried back to a compressing machine, and is thus used over and over again without waste.

In 1854 Dr. John Gorrie of New Orleans, La. patented the first "Air Machine". This is the favorite system for use on ocean steamers. Here the gas is compressed and the process is much the same as that above described except that the air is liberated directly into the cold room thus doing away with pipes in that room. Besides being cooled, the air must also be dried or it would carry moisture to the products. To remove this moisture from the compressed air, it is allowed to escape thru pipes which contain chloride of lime. This absorbs all the moisture.

In 1865, a Frenchman patented the absorption or aqua ammonia system. Here, as in the compression system, anhydrous ammonia (free from water) is used. This anhydrous ammonia is secured by heating aqua ammonia (ammonia dissolved in water). The water does not vaporize as readily as does the ammonia - that is the former boils at 212° F. while the latter boils only at 32° F. so that it is easy to separate the two. The remainder of the process is much as that above described.

Uses of Cold Storage as applied at Present.

Without cold storage, many of our most extensive modern industries would be impossible.

Among the important products now successfully kept in storage may be mentioned apples, pears, grapes, peaches, plums, berries as well as dried fruit, meats, butter and eggs.

Many of these could be kept throughout the entire year if necessary. Below is a table intended to show the length of time of preservation, and also the best suited temperature for keeping some common products. It is compiled from various articles written on this subject, and also from the results of experiments carried out by two stations.

Product.	Best temperature.	Time of keeping.
Winter apples.	34 $\frac{1}{4}$ F.	6 to 8 months
Pears.	35	3 - 4 months
Peaches.	37	$\frac{1}{2}$ - 1 "
Grapes.	40	2 - 3 "
Plums.	40	$\frac{1}{2}$ - 1 "
Berries.	40	$\frac{1}{2}$ - 1 "
Tomatoes.	40	$\frac{1}{2}$ - 1 "
Celery.	35	8 - 9 "
Potatoes.	38	10 - 12 "
Asparagus.	34	1 - 2 "
Cabbage.	34	8 - 10 "
Eggs.	35	8 - 9 "
Butter.	32	10 - 12 "

It is, however, utterly impossible to state definitely the right temperature or the length of time that products will "keep".

Much depends on the season whether wet or dry, and on the variety whether fleshy or juicy, and on the quality of the product when stored.

In 1893, there was an experiment carried on in New South Wales, with several varieties of each of the following products, apples, pears, plums, peaches, grapes, pine apples and tomatoes.

The experiment commenced on January 25, and ended in the following August. (The seasons are about six months later than ours that is they have summer when we have winter.) The temperature in that cold room ranged from 36°F to 45°F.

Usually it was quite even and low. There was a circulation of dry, fresh air.

In this experiment, the aim was to have many varieties as well as fruit from ^{all} sections of the Country represented. This was to learn the effect of varieties, of climates, and of soils.

The apples were kept from three to four months.

Winter Melia pears kept two months
Solid-fleshed plums kept for nine weeks.

Grapes with tough skins, firm flesh and berries set loosely, kept best. The most satisfactory results with grapes, were obtained when the fruit was cut and allowed to remain in the sun-light for a few hours before being packed.

This would relieve them of some of the surplus moisture. The grapes were then packed in barrels, each bunch being well imbedded in sawdust. The whole was packed quite firmly.
Tomatoes wrapped with tissue paper kept for a month.

Experiments at the Kansas Station.
 During the summer of '98, the Department of Horticulture made arrangements, with cold storage firms in Kansas City and Topeka, to carry on a series of experiments with various kinds of fruit.

Besides this, there was a cold storage room of small dimensions established at the Kansas Station. Below are some of the main points that were to be answered by these experiments.

1. Kinds of fruit that can be stored profitably.
2. Best methods of handling the fruit.
3. Suitable packages and ways of shipping.
4. Length of time that fruit can be kept.
5. Best varieties for storage.
6. Proper temperature for fruit while stored.

Experiments were carried on with apples, pears, peaches, plums, grapes and tomatoes.

As to peaches, the following conclusions were drawn.

1. The fruit must be of the very best quality.

2. They must be picked before they begin to soften.
3. The individual peaches should not come in contact with each other. If the fruit is not very large it can be packed in egg cases.
4. Keep at an even temperature of about 36° F.

As to grapes, the conclusions of the experiment in New South Wales were verified.

They were packed in sawdust. The average temperature was 40° F.

As in the Australian experiment, red grapes, with thick skins, proved best. Early grapes also showed an advantage. Under favorable conditions, they were kept from six to eight weeks. The most successful varieties in this experiment were, Delaware, Agawam and Brighton. Catawba will probably also prove successful.

Plums with firm flesh - that is - those with least juice - did well. The Department managed them a month.

Tomatoes, wrapped with tissue paper, were held for a period to two months. They must be picked before ripe. - Just before they change color. These were kept at a temperature of 40° F.

Among other varieties of pears in this experiment were Keiffer,

Vicar of Wakefield and Winter Nelis. Some of the last named variety were preserved till the first of February. The following suggested themselves.

1. Keep late pears at about 34° F.
2. Select varieties with large open cores.
3. Pick while still hard.
4. Wrap each fruit with tissue paper.

Successful pear growers in Kansas have found it profitable to store the pear crop when the market was dull.

Experiments with Apples.

The Kansas Station had in the experiment ^{among others} seven of our best varieties of late apples as follows:-

1. Missouri Pippin.
2. Ben Davis.
3. Minesap.
4. Jonathan.
5. Rawlee Janet.
6. Rambo.
7. York Imperial.

The results showed that winter apples keep best at 34°F while summer varieties should be stored at about 36°F .

As with other fruit, the varieties that are the least juicy give the best result. Only the first quality of apples should be packed.

Pick as soon as the fruit is well colored - while it is still hard.

Barrels should be carefully packed as follows: Place several thicknesses of paper in the bottom of the barrel.

Now put in the first layer of apples by hand, all stems down and on top of these the second layer so as to fill up the cracks, this time putting the "blown" or "blush" downward. This is to show the fruit to the best advantage when the barrel is opened. Barrels are opened at the end that was below when packed, and all labels etc should be placed at that end.

After the first two layers are in place, the fruit may be gently poured into the barrel. Use a press to close the barrel. It pays well to pack apples carefully.

Storage with Natural Ice on the Farm.

In order that the farmer may get all the direct results of cold storage, it is necessary that he have his own cold house. With this he can reap the profits that might otherwise be divided between the storage company, the railroad and the commission merchant.

With the fruit stored at home, he is also at liberty to sort it from time to time as well as enjoy it with his family.

Usually his stock pond would supply an unlimited quantity of ice. He could put up enough ice so that he would ship fruit, he could ice his refrigerator car thus making transportation much cheaper.

A few remarks on the

Storing of Ice

might be in order here. First, Ice should be stored only in freezing weather to avoid "rotting" and that it may be dry to handle and also to keep it from freezing together in ice house.

Second Large cracks should be prevented in the stack of ice when stored - that is the pieces should over-lap as a stone wall. If such cracks be allowed, currents of air are to occur.

Third, When the room has been filled, the whole should be covered with dry sawdust at least one foot deep. Among the several sources of waste to ice may be mentioned the following.

1. Water flowing down over the ice.
2. Vapor in the air.
3. Warm air.
4. Evaporation.

This latter takes place continually in warm weather as well as when cold and its importance is generally under-estimated.

Plan of a Building for Cold Storage on a Farm.

Where ice is plentiful as it usually is here, there is no reason why farmers cannot enjoy at least some of the benefits derived from cold storage. Where the farmers have little to store, several of them might own and operate a storage building in common. There are however very many farmers in Kansas

who produce from 500 to 2,000 bushels of apples or the equivalent of other fruit and these can well afford to own and operate cold storage houses individually.

Look what enormous gains were possible during the past season with apples in storage and yet very little of the money made thru storage of fruit went back to the farmer.

We here suggest a plan for a building which would be large enough for co-operation of among several ordinary farmers or large enough for one farmer only who was a specialist in the fruit and vegetable line. It is intended to hold from four to five hundred barrels of apples or its equivalent and also enough ice for the entire year. A building of somewhat larger or smaller dimensions would be built on practically the same plan.

It is intended to hold from fifty to seventy-five tons of ice.

The structure is to be a two-story, frame building having the ice in the second story.

Following are the exterior dimensions

Length 30 ft.

Width 20 ft.

Height to eaves 16 ft.

Entire height 26 ft.

The inner dimensions of the storage room are to be:-

Length 28 ft.

Width 18 "

Height to ceiling 10 "

The walls are to be about thirteen inches thick. The insulation which was formerly secured by filling spaces in the wall with charcoal, sawdust or chaff, is to be secured by having "dead air" space in the wall.

These air spaces have of late proven to be the best as well as the cheapest insulator of all.

By dead air spaces we mean spaces filled with air so that there can be no circulation or passage to the outside. If these air spaces were continuous from bottom to top in the wall, there would be induced currents of warm and cold air and we must remember that the chief way for transferring heat thru air is by convection. To prevent these movements of air in these spaces, the latter are often loosely filled with shavings.

The outer air space is to be six inches across while the inner one is to be only two inches across. The main studs are to be two by six inches.

On the outside of these are to be placed plain boards then building paper and over this, weather boards.

On the inside of the studs are to be two layers of matched boards with paper between as before.

In order to form the second or inner air space, there are two by two studs fastened to the inner part of the wall, and these studs are again covered with two layers of boards and one of paper as before described. Where windows are placed, not fewer than three sashes should be used so that there be at least two air spaces formed. This insulation must in like manner be provided for the under side of the rafters. Wooden shingles give the best results.

The second floor is so constructed that it slopes toward the center from the sides.

At the center, a gutter is provided in which the water from the melting ice is caught. The entire second floor must be covered with metal to ensure perfect dryness below. There must be several places or passages thru the second floor thru which the air can pass.

Such a building while it would seem to cost considerable at the start, would be of very little expense afterwards. It is estimated that where ice need not be hauled more than two miles it can be stored at about 25-cents, per ton.

General Conclusions.

1. It is a generally admitted fact that cold storage in many cases is a grand success.
2. Many failures with fruit are traceable back to careless and ignorant packers. Apples were kept by the Kansas Station with a shrinkage of only two per cent. as a result of careful packing while apples packed by farmers and placed in the same storage room, shrank as much as thirty per cent thru decay etc.
3. Fruit should be cooled gradually, and after that it should not be allowed to get warm again until it is to be used.

- If intended to be sent to storage in a large city, the fruit should be sent in a refrigerator car. This car should be supplied with ice some time before using for fruit. These cars are supplied with ice by either the Rail road company or by the individual. It takes about four tons of ice per car.
4. Store only the very finest quality, and in the best method of which you know.
5. Follow the advice given by experiment stations and managers of cold storage plants and there is hardly a chance for failure.

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