

## THE SCIENCE OF THE PRESERVATION OF FOODS BY COLD.

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THE commercial and scientific aspects of the problem of the preservation of foods are so intimately related that it is not possible to separate them in any discussion of the subject. If a food, whether animal or vegetable, has no revenue-producing value when to its preparation is added the cost of transportation and sale, its surplus is simply allowed to revert by ordinary decomposition to its original constituents, and even may become during this process a source of expense in the matter of the abatement of nuisances, either to the possessor of it or to the municipality wherein it happens to be.

Nothing better illustrates the need of a widespread knowledge of how food products, whether animal or vegetable, can be preserved than the evils attaching to organic decay, whether as regards commercial losses or those incident to unsanitary conditions.

M. J. de Laverdo, in his work "Conservation par le froid des Denrées Alimentaires," says:—

"Dans l'histoire des échanges des denrées alimentaires périssables l'intervention du froid artificiel est destinée à jouer un rôle à coup sûr plus considérable que les applications de la vapeur."

In this he simply means to indicate, in an epigrammatic way, that so remarkable are the results of the application of cold in preserving foods, that it becomes of even greater importance than the question of whether a vessel is going to take one or two weeks or months to go to Europe from America or Australia.

With the directness of the French scientific mind, Laverdo at once orients himself and sets forth his subject in a simple way by saying that the mere production of cold by an ice chamber is a very poor means of providing refrigeration, since it neither produces readily a sufficient degree of cold nor supplies either of the other two factors necessary to food

preservation, viz., *a proper relative humidity* of the air of the ice-chamber or its *aseptic condition*.

Now, where it is possible in practice to render food products sterile, *that is free from all microbes of decomposition*, as it is to prevent the multiplication of such microbes, it is apparent that the question of cold or low temperature would scarcely need to enter into the problem; but it is the impossibility of effecting this in practice that makes the scientific application of cold to the preservation of food products of inestimable value.

We may therefore, in the discussion of the subject, consider (a) The part cold plays in the preservation of foods; (b) The methods most readily applicable in different circumstances and conditions to their preservation; (c) Its application to different food-stuffs.

(a) The popular idea is that cold absolutely kills all vegetable life, of course including bacteria and fungi: but we learn by experiment, as well as by observation of plants living through winter at even ( $-40^{\circ}\text{F.}$ ), that the worst that takes place in them is the delaying of growth or of cell multiplication. It has been shown that liquid air ( $-190^{\circ}\text{C.}$ ) does not destroy some bacteria, that fungoid growths develop even on the surface of frozen meats in storage at ( $-10^{\circ}\text{C.}$ ), and that lichens multiply freely on the arctic snows.

Now, while this is true, it is nevertheless important to realise *that a temperature below  $50^{\circ}\text{F.}$  does lessen very greatly multiplication of the ordinary germs of fermentation and decomposition, if other favouring conditions, as dryness, are present*. Yet in order adequately to prevent the growth of such microbes in successful cold-storage operations, a temperature not exceeding  $40^{\circ}\text{F.}$  is in practice essential. As microbes are simple protoplasmic cell forms, most of which will multiply in fluids, whether on the surface as aërobes, or in their deeper parts as anaërobes, it is plain that they will grow but slowly on dry surfaces or in tissue drying out in the open air and sunshine, where the wind not only renews the air about, for instance, newly killed meat, but also causes, as in the bright dry air of the western plains or the veldt of South Africa, *a rapid evaporation of the moisture of dead tissues*.

In such climates, indeed, we have supplied every element necessary to the scientific preservation of foods, viz., *cold, dryness*, and a practically *aseptic* air, and upon the conjunction of these three conditions depends the whole science of cold storage. Normal air with its free outer movements (as, say, a zephyr at five miles an hour, with the barometer at 30 inches), even out at sea has an average relative humidity of from 70 to 75 per

cent. of saturation, and this in practice is found adequate to maintain dry surfaces. If this condition is imitated in a cold storage chamber, it is apparent that we must provide either that the air be kept constantly in motion around the stored products and removed from the outside, or that some method of absorbing moisture be present.

Experience in *cold storage*, indeed, has shown that microbes which will grow in frozen meat at 25° F. will not multiply even at 40° F. if the air has the normal humidity of 70 to 75 per cent.

It is apparent, however, that *given the initial freedom from microbes of fruits, carcasses, etc.*, whether on or in them, the effectiveness of a cold storage plant will be *greatly assisted*. *Ex nihilo nihil fit* is the motto of the early germ theorists, and simply means that from nothing, nothing comes, and that in this case if food can be maintained free from germs, it may be preserved indefinitely, as we see practically exemplified in the canned food products.

It is further maintained that (a) the carcasses of diseased animals, or of those badly slaughtered (that is, not well drained of their blood, or killed in foul-smelling abattoirs, or by men with filthy garments, or using filthy knives and apparatus infected with germs) will rapidly undergo putrefaction; (b) that the milk from perfectly healthy cows, but having filthy udders, taken by men with filthy hands and garments into foul, wide-mouthed pails, is often found to have 100,000 microbes per cc. instead of a minimum of, say, 5,000 if drawn under all reasonable precautions; (c) that butter made from milk infected with different microbes, unless the nitrogenous materials in solution in the water present be well worked out by separating it very thoroughly from the butter-fat, will undergo rapid alteration through the multiplication of germs present; and (d) that fruits that have passed through the dangers of *black-spot* and the other field enemies during their growth, will rapidly be destroyed by the *fermentative* microbes during packing, in transit or storage, unless great care is taken to maintain whole their protecting rinds during picking and packing, and by reducing at the earliest moment their temperature to at least 40° F., and by protecting the fruit by tissue-paper wrappings or by paper-lined boxes during train transport.

In a word, it has been proved true by experience that though meat, eggs, game, fruit, etc., may be preserved by moderate degrees of cold fairly well for a time, yet, if it be our aim to obtain the highest scientific results in food preservation, we must endeavour to adopt at every stage such methods as will supply each of the three factors, *cold*, *atmospheric dryness*, and *cleanliness or asepticism*.

(b) As regards the methods of producing cold, it is obvious that we have two, viz., that by ice and that by artificial means. As regards the use of ice, it is manifest that in cold climates, like Canada, it is desirable to utilise so natural a source of cold to the greatest degree possible. By it temperatures approximating  $40^{\circ}$  F. may be obtained; and if such can be attained in practice along with other conditions, this cheapest source of cold has much to recommend it. Ice can in a small way be utilised at every farmhouse or small shop or house by having a chamber in the ice-house with ice practically on all sides of it, or by the ordinary house refrigerator. But, ordinarily, owing to no definite provision being made for proper ventilation or for securing a proper relative humidity, the advantages of cold are largely lost. Manifestly it is essential that a nearly constant temperature be maintained, and that circulation of air within the chamber be regular and definite in amount. If this can be assured, then, meat can be almost equally well preserved at any temperature between  $32^{\circ}$  and  $40^{\circ}$  F. with a relative humidity of 75 per cent. As the vapour tension between, for instance,  $1^{\circ}$  C. and  $10^{\circ}$  C. is as 4.3 to 9.1, it is plain that, with a relative humidity of 75 per cent. at  $7^{\circ}$  C., saturation is reached at about  $4^{\circ}$  C., so that the permissible range of temperature with such humidity is very small indeed.

The following table, in Fahrenheit scale, of relative humidities illustrates the situation:—

Temperature in Degrees.	Grains of Water 1 cub. ft. Air.
0 degrees F.	.345 grs.
10    "	.841   "
20    "	1.229   "
30    "	1.96    "
40    "	2.86    "
50    "	4.05    "
60    "	5.75    "
70    "	7.99    "
80    "	10.94   "
90    "	14.14   "
100   "	19.19   "

Thus, if one cubic ft. of air at  $40^{\circ}$  F., having a relative humidity of 75 per cent., holds 2.13 grams of moisture, then a fall of  $4^{\circ}$  means its practical saturation. Hence no greater range of temperature than  $2^{\circ}$  is allowable between  $30^{\circ}$  and  $40^{\circ}$  F. if an optimum is to be maintained.

To succeed in this with a large ice-chamber exposed to the varying outside temperatures is very difficult; and in practice would mean surrounding the cold chamber with ice, and having a non-conducting door, ante-room, and some means by which any air introduced from the outside

is delivered at the same temperature and at the same rate per minute. This would only be possible by chilling the air by passing it through, say, a duct circulating over or through the ice, or by its being delivered by a fan at a definite rate according to temperature.

The method approximating this desideratum is to construct an ice-chamber so carefully that its walls will in practice be a non-conductor. Of course, this is a condition purely relative; but, as shown in the report of 1905 by Prof. Ruddick, Dominion Dairy Commissioner, it is possible, as shown by experiments, to approximate it.

The best means found in the test experiments made was by a 1 ft. air-space in walls, ceiling, and floor, being filled with well-dried spruce shavings, about 8 lbs. to the cubic foot, covered on the outside by two layers of tongued and grooved siding, with two layers of damp-proof paper between, then 1 in. air-space, then building paper and another inch of tongued and grooved siding; while on the inner side, toward the ice-chamber, from without inward is 1 in. tongued and grooved, then building paper, then 1 in. tongued and grooved, then an inch space, then 1 in. tongued and grooved, two layers damp-proof paper, then 1 in. tongued and grooved.

This was more than twice as effective as a 6 in. hollow air-space, with two layers of tongued and grooved siding both outside and inside, with paper between both, as 7 to 9°, in loss of ice, compared with a 10 in. hollow block replacing the tongued and grooving and paper on the outside, as in first experiment.

Where, as in a cheese factory, a cooling room and curing room are demanded, which requires a temperature below from 50° to 60° F., it is apparent that with a moderate supply of ice and a range of temperature of, say, 5° to 10° F., possible without injury, the necessary conditions are readily obtainable.

Assuming, however, that such cold storage is in practice attainable, provision can be made in a relatively simple way for maintaining a proper relative humidity, approximating 75 per cent. This is by allowing fresh air to circulate over the bare upper ice-surface and there being cooled to descend thence along the ice-chamber into the cooling or store-room. As it will gradually rise in temperature in this room, its relative humidity will be lessened relatively, and the same air passing over the ice is again cooled, and so a circulation is maintained. As some fresh air is desirable, it should enter upon the top of the ice, so that it would there precipitate its condensed moisture.

Great care must be taken that only cooled products be placed in the

cold storage, since it is evident that a tub of butter at 60° F. placed in cold storage would both cause a notable increase in temperature of the chamber, and further by its moisture increase the relative humidity of the room. Indeed, only great care will enable any cold storage plant to be operated effectively, since each pound of food will carry with it its definite amount of specific heat, which has to be provided against.

The following table gives the specific heat of different substances, which specific heat is greater in proportion to the percentage of water and solids in any products:—

Thus—	Water. per cent.	Solids. per cent.	Sp. Heat above freezing.	Latent Heat of freezing.
Lean meat ..	72	28	0.77	102
Fat meat ..	51	49	0.60	72
Veal .. ..	63	37	0.70	90
Fat Pork ..	39	61	0.51	55
Eggs .. ..	70	30	0.76	100
Potato .. ..	74	26	0.80	105
Cabbage ..	91	9	0.93	129
Cream .. ..	59.2	30.7	0.68	84

For practical purposes it may be assumed that the specific heat of all kinds of produce is about 0.8. On this basis the amount of R. (refrigeration) required to reduce the T. (temperature) of the product to that of the refrigerating room is  $R = P$  (weight of substance)  $\times (T - t)$  0.8 units (T being temperature of products, and t. that of room).

As this cooling, if carried on in cold storage, will proportionately increase the humidity with the decrease of temperature, this increase must either be got over by vigorous circulation of air in the manner indicated, or by a fan with warmer dry air introduced, *or as is sometimes done by placing hygroscopic substances, as chloride of lime or magnesia, on the floors of the storage chambers.*

Where meats are to be dealt with in such cold storage, it is yet more essential that they shall have undergone a preliminary rapid drying of the surface and an internal cooling of the tissues; but as they contain when killed about 70 per cent. of their weight as water, it is apparent, unless great care and cleanliness are exercised and a constantly changing and drying air is maintained, that *deep tissue anaërobic changes* (as by *Bacillus vulgaris*) are certain to occur. This cooling is effected in the preliminary cooling room by a free circulation of fresh air by means of a fan ventilation, improved if filtered by passing through a damp coarse canvas, and by meeting a spray of water.

The storage of fruit, holding the temperature of sunlight and outer air in its tissues, will manifestly depend upon the same rules; but if placed

in boxes of, say, 40 lbs., and exposed to free night-air before storing, the preliminary cooling may in part be effected. As regards the cold storage rooms, the same estimate may be made of the amount of work to be done in cooling, and the same means be insured for normal dryness, since the decomposing fungi are especially dependent for their action upon abundant moisture.

It is, however, very evident that, while ice in Canada can be of very great practical utility in small stationary plants, it is very difficult in practice to make it applicable to the requirements of transportation. Refrigerating cars have, however, been of use on relatively short runs, where the preliminary cooling of products has been carried out.

The report for 1905 of the Dominion Dairy Commissioner gives the reports of 87 creameries in the eastern townships, tested at least three times in the season at the point of shipping. It was found that 78 packages were under 46° F. and 102 over 46° F.; while of 832 marked packages, arriving at Montreal over C.P.R. and G.T.R. from the Province of Quebec, the temperatures were:—

Number of Cars carrying pcks.	Number of packages.	Temp. at point of shipping.	Temp. at Montreal.	Decrease or Increase.
13	190	57·3	56·8	0·5 decrease.
40	463	53·0	53·6	0·6 increase.
21	179	53·1	53·3	0·2 increase.

It is apparent from these illustrations that the ideal of cooling in railway transportation has not yet been nearly approximated in practice, since in 1,943 packages arriving in 1905 in Montreal, those from Ontario had the highest temperature, being 56° F., and those from Manitoba and Alberta (4 packages) were lowest, being 52·5° F.; though the difference in distance and time may not have left these products in as good a condition as those from nearer points. The ice capacity of ordinary cars is from three to four tons. It is apparent, as pointed out in the report, that there is an essential necessity for small storage rooms being erected at either farms or railway depots, where butter, fruit, etc., can be stored, and rapidly cooled, as upon this, even more than upon subsequent chilling, the goodness of products depends. The inestimable value of such may be understood from the arguments used by M. de Laverdo for the installation of refrigerating machines on trains instead of ice cars. He points out (a) the impossibility of obtaining by ice a temperature approximating 32° F., but especially of producing it rapidly in the case of our small fruits. (b) He says that to get a rapid lowering of temperature energetic ventilation is necessary. (c) That the more watery the products (small fruits) the nearer to freezing point should the temperature be rapidly

brought, while the high specific heat of such makes it impossible to get low temperatures speedily in ice chambers. No matter how great is the quantity of ice, such will remain at a temperature of  $12^{\circ}$  to  $15^{\circ}$  C. ( $48^{\circ}$  to  $50^{\circ}$  F.), while at the same time the rapid internal cooling of the chamber means a saturated air. Under such conditions the ripening of fruits will proceed, and decay will not be slow in declaring itself. As a result, he says, fruit, fresh at Marseilles, will have notably degenerated on arrival at Paris; while, on the other hand, strawberries harvested in California and chilled immediately in a cold chamber to  $1^{\circ}$  C., energetically ventilated, then put into cold chambers on trains or in ship's holds, will arrive in London twenty days after in excellent condition, though fruits from the Mediterranean have undergone change within three days after shipping.

(d) As a matter of actual experience, a company in 1902, in spite of a warning as to the necessity for preliminary chilling, did install ice chambers in cars from the south; but, after cruel experiences, the company is now establishing refrigerating chambers at points of shipping. This, which is absolutely essential, may be carried out in a cold storage depot, where cars can be loaded, or in a sort of chilling gallery, into which cars or even whole trains can be run. This last method is actually carried out in the southern states, where banana trains are run into a shed where  $15^{\circ}$  C. is maintained.

(e) De Laverdo, however, insists that the *aerothermic car*, which produces cold *en route*, is destined to be the cold storage of the future railway train. It constitutes a complete cold storage chamber in itself, gets rid of all the disadvantages of ice cars, chills products rapidly, and keeps them cool and dry. It consists of a dynamo attached by chain to the axle and so arranged that, no matter what the rate of the train above 35 kilometres, the apparatus makes always the same number of revolutions. This current is sent to a receptacle on the compressor. This compresses the liquefiable gas (ammonia) in the condenser. The gas is liquefied, thence evaporated through pipes on the floor and walls of the cold chamber. Further, when the minimum temperature fixed in advance is attained, a thermostat cuts off the contact and arrests the compressor, which again, as the temperature tends to rise, makes the contact with the compressor.

(f) To the objection that it only acts while the car is in motion, and that it would be necessary to chill the car prior to departure, De Laverdo shows that this is overcome, since to the apparatus is attached, beneath the car, an adjustable electric generator, to which a current may be attached at will. Such cars have been tried on railways in France during



1905-6 running products from Lyons and Paris to London; soon many of them will, he says, be on railways.

As regards refrigerating machines, as generally installed in all sorts of manufacturing and cold storage establishments, it would be useless to attempt the discussion of the relative economic merits of *air absorption* and compressor machines, since such are engineering questions; but now most of the authorities point to the compressor machine with ammonia as being most simple for general use, and with carbonic acid when installed on shipboard as being equally effective. This machine uses the latent heat of vaporisation of substances having a low boiling point, as  $\text{NH}_3$ ,  $\text{SO}_2$ , and  $\text{CO}_2$ . The vapours created by vaporisation of the refrigerating medium in the refrigerating cells enter a compression pump, which is operated by an engine, which forces the vapour into condenser coils, where they are liquefied with the aid of cooling water. The liquid enters a liquid receiver, from which it is allowed to enter the refrigerating coils as required. The process is continuous and represents a cycle of operations, the substance used returning to its original state. Apart from the production of cold, the ice machine in a chamber promotes a gentle circulation which serves to dry the air; since, as the pipes are at a temperature below freezing, the air near them deposits its moisture, which freezes on the pipes, and so lessens the moisture of a chamber. No outer air requires to be introduced after the minimum temperature is reached, the outer surface of the products having been dried during the cooling process; although in large storages an electric fan serves to renew the air in contact with the carcasses or other products.

(g) In the refrigeration of different classes of products, with the very different physical constitution of different foods, it is natural to think that no mere rule of thumb cooling applied indifferently would be productive of equally good results in all cases. Thus with meats, healthy animals, cleanliness at every stage of killing, the introduction of carcasses alone (not animals with skins on) would be allowable. Again, rapid drying of the surfaces of the carcasses by a current in the slaughter-houses, to get rid of the body heat of  $102^\circ \text{F}$ . and of the moisture, are manifestly routine essentials. Of course, this is done yet better in a cooling room as an ante-room to the refrigerator; since, if the chilling and drying do not go on together, or the surface is frozen before the deep tissues are chilled, internal putrefactive changes in the deeper tissues are likely to occur. Hence carcasses, well killed, well bled, well dried, and well chilled, should alone be allowed into cold storage. The internal organs will not keep as well as the harder tissues, and should be separated from carcasses. Such should be kept at between  $36^\circ$  and  $40^\circ \text{F}$ . It is found by experience that

mutton can be preserved in such a manner for 30 to 48 days; beef for 24 to 28 days; veal from 10 to 14 days, and pork 15 days. After these periods the meat presents an appearance exactly like that of meat being in the air in winter in butcher's shops, dry on the surface and firm and hard, its dryness having extended into the tissue some 2 or 3 millimetres, and beneath this the meat is bright and fresh in appearance.

It is apparent that when meat has arrived at what one may call the statical condition above mentioned, it will remain fresh, owing to its surface hardness and dryness, even in the much warmer butcher's stall: while it must not be forgotten that such chilled meat, if brought into warm summer air, should be placed where there is a wind current, otherwise its cold will cause moisture to condense on the surface. It is a difficulty to be specially provided against where meat leaves ships for transportation by train, etc. Properly managed, this refrigerating of meats will serve to notably improve the tenderness and flavour. Some of the further advantages in the refrigerating of meats are in the lessening of danger of epizootics owing to the trade in dead meat. Of course, the freezing of meat introduces other problems which demand careful consideration, but which include much the same principles as its chilling. Before freezing, the meat must be gradually chilled and the surface dried, if the  $15^{\circ}$  to  $20^{\circ}$  C. are to penetrate through and through. Especially is this necessary in beef carcasses, and the effect of decongelation or thawing out is of even greater importance, and varies with different animals, the meat of sheep withstanding freezing better than beef, but with care meat may remain good for nine months. Meat coming out of cold storage takes from 24 to 48 hours to thaw, and should be subjected to vigorous ventilation in a chamber at  $35^{\circ}$  to  $40^{\circ}$  F. Thus treated, it will remain good for several days in the butcher's refrigerator.

Refrigeration causes poultry to lose its fresh appearance, making it look poor and dull-coloured, and all the more if the birds are young or poor. This may be lessened by wrapping the birds in cloths or parchment blotting paper. Ducks, geese, and turkeys endure chilling better, as they do not lose flavour much or change colour so rapidly. If, however, they are to be stored for keeping several months they must be wrapped in paper, after a previous removal of entrails, etc., then placed without touching each other in a chamber for three days at  $15^{\circ}$  C., thereafter brought to  $5^{\circ}$  C., and placed in rows on shelves and not in cases. Chickens will not keep longer than four months. They must be thawed very gradually for several days at, say,  $1^{\circ}$  C., and in a drying air. Enormous amounts of frozen poultry are stored by American firms, as Armour and Co., and kept for months.

Many difficulties exist in the storing of fish, according as they are long in the nets or in the boats before being landed. They should, in any case, if for chilling, be at once cleaned and washed as soon as landed from the vessels, and placed in the ice-houses covered with broken ice, which, however, as it melts tends to remove the mucilaginous envelope, and lessens the keeping qualities by making the flesh flabby and soft. The freezing of fish has been most perfected on this continent. The developed method is where the fish are carefully stored in shallow galvanised basins over the refrigerating coils, maintaining the temperature at about  $-25^{\circ}\text{C}$ . When once frozen solid, the fish are separately removed and placed in water at  $0^{\circ}\text{C}$ ., when a sheath of ice forms over them. They are then placed frozen in boxes and, placed in the refrigerator, kept at  $5^{\circ}\text{C}$ . Such will keep well for three months if the coating is preserved, though there is a tendency to a stretching of the skin resulting in fissures, with an exposure of the flesh.

In the refrigerating of butter the essential aim is to render inactive the microbes necessarily present, perhaps most of all *B. vulgaris* and *Clostridium butyricum*, which forms butyric acid in the absence of oxygen.

Of course, this presupposes (a) that the butter is made of a fresh centrifugized cream churned at a low temperature; (b) that it has had the buttermilk well worked out; (c) that it has been put into the cold chamber immediately after being worked; (d) that it is maintained at a temperature of  $2^{\circ}\text{C}$ . and relative humidity of 75 per cent. It may be preserved even longer if the cream has previously been pasteurized. The air of the chamber must be especially protected against odours, whether from outside or from other stored products. Butter kept about  $1^{\circ}\text{C}$ . remains firm for days and may be transported great distances. It is, of course, necessary to store summer butter for winter use, and to carry through May-June butter, said to be best in quality, whence it can be taken when the price is best; but if in storage even after six or even nine months, butter so treated has been sold higher than the fresh butter of the market. It ought on making to be at once carried to a temperature below  $12^{\circ}\text{C}$ ., in order that the cold may penetrate through and through; and thereafter be kept at  $2^{\circ}\text{C}$ . It must be kept as far as possible from air to prevent rancidity from *aerobic microbes*; must be made into small balls, of some 4 lbs., wrapped in sulphurized paper, and placed in boxes lined with pure white paper made dry and impermeable through a coating of caseine or paraffin inodorous wax. It is well to exclude light from the cold storage room.

The cold storage of eggs has enormously increased; of course, they must be fresh to start with, and should be scientifically collected by dealers and candled before storing. They should be scraped and rubbed

with a cloth dipped in vinegar and then carefully packed in boxes, each separate, and placed on the little end, or on a slope, and there should be not more than five or six rows, otherwise they tend to heat; say, 500 or 600 eggs in a case. Boxes must be made of white inodorous dry wood or spruce. Placed in the refrigerator the temperature, whatever is agreed upon (a point disputed, whether  $4^{\circ}\text{C}.$  to  $7^{\circ}\text{C}.$  or  $1^{\circ}\text{C}.$ ), must be constant; the latter keeps the yolk firm, so that it does not touch the shell. Freezing at ( $-2^{\circ}\text{C}.$ ) will not hurt the eggs. It is, further, most essential and difficult to keep the relative humidity at a proper standard. No condensation must take place on the eggs, a matter difficult to prevent because hygrometers of different makes vary so much at low temperature. The best relative humidity is 75 to 80 per cent. and it must not fall below this, as evaporation of egg moisture will take place. Excessive moisture on eggs is most serious, since *torula* and *aspergillus* moulds appear. Eggs should be brought from cold storage gradually into a temperature of  $4^{\circ}\text{C}.$  only after two days, then to  $6^{\circ}$  to  $12^{\circ}\text{C}.$  after four days. This time may be lessened by an active ventilation at  $8^{\circ}\text{C}.$

Such are some of the more important points of detail with regard to the preservation of different food products, for details of which I am indebted to M. de Laverdo's work, and such are in part only matters of personal observation; but they are enough to show that the principles of the application of cold are really three, *biological*, *physical*, and *mechanical*, all bearing directly upon the commercial as well as health aspects of the problem.

I trust that enough has been said to show how great is the problem before us, not alone from the commercial, but from the scientific and sanitary standpoints. While the official work done in the field in Canada has been mostly under the auspices of the Dominion Department of Agriculture, and has been especially directed to the improvement in the quality of our exported products, yet it is abundantly plain that it has an equally great interest for us from the standpoints of personal health, the health of all our people, and the agricultural and commercial progress of all Canada. Were it possible to educate our farmers, butchers, dairymen, and fruit-growers in the essential, scientific principles underlying the preparation and preservation of our food products, and were it possible to supply such to the homes of our people as well as to foreign consumers, a boon perhaps greater than all others together would be conferred upon them, while prosperity and health, and therefore happiness, would be the logical result.