

-----  
Fishery Leaflet 203

Washington 25, D. C.

Reissued June 1948

QUICK-FREEZING TECHNIQUE

Mr. H. W. Dunsford, Associate Member, presented the following paper at a meeting of the Institute of Refrigeration (Empire House, St. Martin's-le-Grand, London, E. C. 1) held at the Institution of Mechanical Engineers, on December 12th, 1945.

The process herein described as "Quick Freezing" is based upon the co-ordinated results of many investigations by scientific research workers. The resultant technique, when applied to the preservation of food, can make a useful contribution to the wellbeing of the people.

The purpose of quick freezing is to preserve the quality, texture, taste, appearance and health-giving properties of foods at their prime.

Meat, fish, poultry, vegetables and fruit can be processed and preserved in such excellent condition that even after prolonged cold storage they are, when cooked, indistinguishable from fresh products.

The technique covers:-

1. Quality control, including selection and pre-treatment of products.
2. Packaging.
3. Quick freezing.
4. Refrigerated transport.
5. Cold storage.
6. Distribution to consumers.

In general terms, freezing -- quick or otherwise -- will not improve a product, but the claim is made that by quick freezing, the freshness and flavour are "imprisoned."

It, therefore, follows that the importance of this first step in the technique cannot be over-stressed.

Chemical and mechanical aids have been suggested and provided to check for quality but the food industry is confronted with a greater spread in the quality of the raw material than probably any other existing industry.

---

Note: This article appeared in Modern Refrigeration, December 20, 1945, pages 283-284.

The success of the quick freezing industry, however, must be based on definite high standards of quality, and it will be to the ultimate benefit of all concerned within the industry -- producer, processor and consumer alike -- to see that such standards are established and recognized.

The processing of garden peas occupies a major place in the industry's production programme, and the quality control used is typical of the attention given to detail that is both necessary and justified.

This control should embrace consideration of soil conditions, variety of seed used, maturity of crop and harvesting conditions, hygienic mechanical handling during shelling, grading and blanching, visual inspection and packaging. Throughout these sub-processes speed of operation and maximum cooling efficiency combined with a very high standard of plant sanitation, should be insisted upon.

Unlike the canner, who sterilizes his product at the end of his process, the frosted-food producer is up against the fact that quick freezing is in general a preserving agent of plant tissue rather than otherwise; it is quite possible that bacterial life may be held viable under refrigeration for centuries.

The criterion of satisfactory equipment, for the processing of frosted foods, is the ease with which it can be cleaned, and wherever possible it should be self-cleaning.

Standards for bacterial counts of quick-frozen products have been recorded -- such standards are extremely necessary for staff guidance.

It naturally follows that the higher the bacterial count of a product, the greater the necessity for shortening the period between defrosting and consumption. Conversely, the lower the original bacterial count, the longer the useful life of the product.

Owing to the rapid rate at which bacteria multiply -- under reasonably favourable conditions the numbers double in twenty minutes -- additional precautions beyond keeping the plant in a highly sanitary state are usually found necessary.

Since a low temperature inhibits bacterial growth it is naturally sound practice to keep the product below atmospheric, but above freezing, temperatures where possible, and to shorten the time to the minimum between harvesting and completion of quick freezing.

Autolysis represents actual self-digestion by enzymes; it is therefore essential to inactivate the enzymes during processing. Blanching or sub-zero storage is usually employed for this.

Proper packaging is vital.

The quality of the processed product can be adversely affected -- both during the actual quick freezing and subsequent cold storage -- by oxidation and desiccation.

1. Oxidation is the combining of oxygen with the natural fats and oils.

2. Desiccation is the gradual evaporation of moisture from the product; this action is frequently called "freezer-burn."

Efficient packaging will help to effectively offset the detrimental effects of oxidation and desiccation, both during quick freezing and cold storage, by guarding the product against contact with air.

The system and the type of apparatus, combined with the temperatures used during the actual quick freezing, influence the selection of packaging material.

Not infrequently cost also influences the selection, particularly in low priced commodities like quick-frozen herrings.

Primary packaging materials that will pass more than 1 gram of moisture vapour per square metre of surface per 24 hours at a temperature of 70° F. and a humidity differential of 50 per cent, are not suitable for 0° F. storage of one year's duration.

Secondary packing should be water repellent on its outer surface, and have good thermal insulation value. Commercial necessity demands that it be reasonably robust, light in weight and cheap enough to be non-returnable.

The design of the container should give the maximum holding capacity consistent with rigidity in handling and stacking, and have the minimum external surface area, thereby reducing heat infiltration.

In actual practice a rectangular corrugated cardboard container with a "water-glazed" surface, with one or more inner liners, has been found satisfactory.

Openings in the container must be overlapping, and the flaps secured to minimize gas (CO<sub>2</sub>) or air leakage.

It is not the purpose of this paper to discuss the relative merits of the many methods and types of apparatus used in obtaining and in endeavouring to obtain quick freezing.

It is generally accepted that speed in reducing the temperature of a product prior to cold storage is very desirable. There appears to be a vague acceptance, by the interested parties, that the use of the term "quick frozen" qualifies this desirable state of affairs. Surely the permitted use of the term "quick frozen" should be qualified by definite performance in the rate of freezing.

Various well-esteemed research workers have published definitions that could be used to qualify the use of the term by the industry.

Some research workers appear to favour the method using the time taken to pass through the "Zone of Maximum Formation" (31° F. to 25° F.) as a standard; others propose that it be defined as freezing which progresses through the body of the product at 0.3 centimetres per minute, or faster. Alternatively, it has been stated that the size of the resultant crystal should not be larger than 70 microns.

It is well worth mentioning here that since crystals grow as a result of variations of temperature, there is no point in producing a small crystal if subsequent cold storage conditions cause damaging growth.

Further, it is not always appreciated, even by some members of the industry, that the cells of flesh products are elastic, but plant cells are not; it is therefore very advisable that vegetables be cooked while still frozen, but with flesh products slow thawing at low refrigerator temperatures gives the necessary time for the water in the intercellular spaces to be reabsorbed and the stability of the complex colloidal system to be restored.

May I digress a little further and add that the cooking period of quick-frozen foods in all cases is shorter than that required for unfrozen foods; otherwise, the cooking processes are similar.

Usually areas of production are remote from main centres of population, and the necessity arises for refrigerated transport. In some respects this problem in England is simplified by the size of the country, but the previous lack of need for a highly efficient system of refrigerated transport has checked development.

War demands have encouraged development, and prototypes have been assembled here which may eventually provide efficient transport for the distribution of quick-frozen products.

Both in South Africa and Canada, the railway companies have successfully operated overhead tank cars prior to the war.

During the last decade the following types have been built for use on the American railways:-

Overhead bunker or roof tank type.

Wire basket type, utilizing dry ice as a refrigerant.

Mechanically operated compressor unit type; these are only suitable under special conditions.

After a very useful life the end bunker type of truck, using salt and ice as refrigerant, is being replaced by the roof tank type for the transport of quick-frozen goods.

Mobile refrigeration, like stationary, also meets heat loads; if heat leaks in, trucks and lorry doors and other openings must be well fitting and sealed in one way or another against air or gas movement. Pre-cooling of insulated trucks is very advisable.

Naturally, sides, ceiling and floors must be well insulated, and wall battens and floor racks provided.

For road transport the same general principles apply -- lighter and more efficient insulating materials, such as fibreglass, which is heat resistant, odourless and proof against disintegration, moisture, spontaneous combustion, vapour and vermin, have been introduced. Dry ice or solid carbon dioxide is in very general use, but for long hauls an automatic compressor, sometimes run from the lorry's engine or from a separate unit, enables 0° F. temperatures to be maintained within the insulated ~~box~~ throughout the run.

For distribution from central cold stores to retail outlets where journeys are short, supplementary refrigeration is not usually provided. A wrapper of fibrous material, with preferably a waterproof outer layer, and speedy handling, are the best provision against undesirable alterations in temperature.

For the journey from retail outlet -- usually a low temperature storage cabinet operating at 0° F. -- to the consumer's home, several thicknesses of newspaper have been found satisfactory; wrapping and returning to the cabinet prior to the journey help.

Many of the stores recently built and managed by commercial undertakings have incorporated provision for handling quick-frozen produce and operating temperatures to -10° F., and in some cases even below that. These improved handling methods are as important as the efficient refrigeration equipment. Apart from the provision of a suitable temperature, the first step in the successful storage of quick-frozen foods was found to be correct stacking to prevent "hot spots."

Standard piling rules have been compiled and should be made a condition of every cold store contract. The rules prescribe that stacking shall start six inches from the walls and extend toward the centre of the room. Floor dunnage of 2 x 4-inch timber must be used and laid wherever possible at right angles to the run of the overhead coils. Dunnage is also used within each pile of containers and between adjoining stacks. Floor racks and dunnage must extend beyond the shipping containers to prevent them from being crushed down over the ends, thereby reducing the air space available for free circulation.

Stacks should not be piled higher than within eighteen inches of ceiling coils, or within five feet of door openings.

The stacking of stock of an initial temperature above 0° F. in the same chamber is not good practice.

Newly processed products should enter the cold store at or slightly below the temperature at which they are to be stored. If the processor has done a good job of work, then this means added refrigeration and not heat load to the cold store.

The last -- but by no means the least -- of the responsibilities of the industry.

Efficient distribution necessitates considerable capital expenditure in low temperature storage cabinets, insulated, and in some cases, refrigerated vehicles, and strict supervision and attention to detail supported by the intelligent co-operation of the distributing staffs.

To get the best results it will no doubt also be necessary to acquaint the housewife with the help the quick-freezing industry can be to her in preparing the daily menus.