

Meat Technology Update

Newsletter 6/04

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Freezing of Hot Offals

Offal products from beef and sheep, that are to be exported in the frozen form, are usually packed into cartons soon after removal from the carcass. This results in warm surfaces (that can be contaminated with bacteria) being located near the centre of a carton, where cooling may be slow. Product at temperatures above 30°C, that is packed in deep cartons and cooled in an air blast freezer, may not meet the refrigeration index (RI) defined in the

Export Control (Meat and Meat Products) Orders. The RI is a value obtained by using a recognised predictive model to calculate the potential log growth of *E. coli* on meat at the site of microbiological concern during cooling to 7°C. For more information about predictive microbiology, refer to Newsletter 5/04. Sets of RI from a process may be used to assess the process using the following criteria: average RI no more than 1.5; 80% of RIs are no more than 2 and no RI above 2.5. The effects of several parameters on the cooling rate and hence the refrigeration index, are discussed in this Newsletter.

Carton depth

Offal products are generally packed into one of two sizes of cartons: full-depth, 27.2 kg cartons (150–170 mm deep); or shallow 13 to 15 kg cartons (100–120 mm deep). For some freezers, carton depth is the main factor influencing the rate of cooling of meat

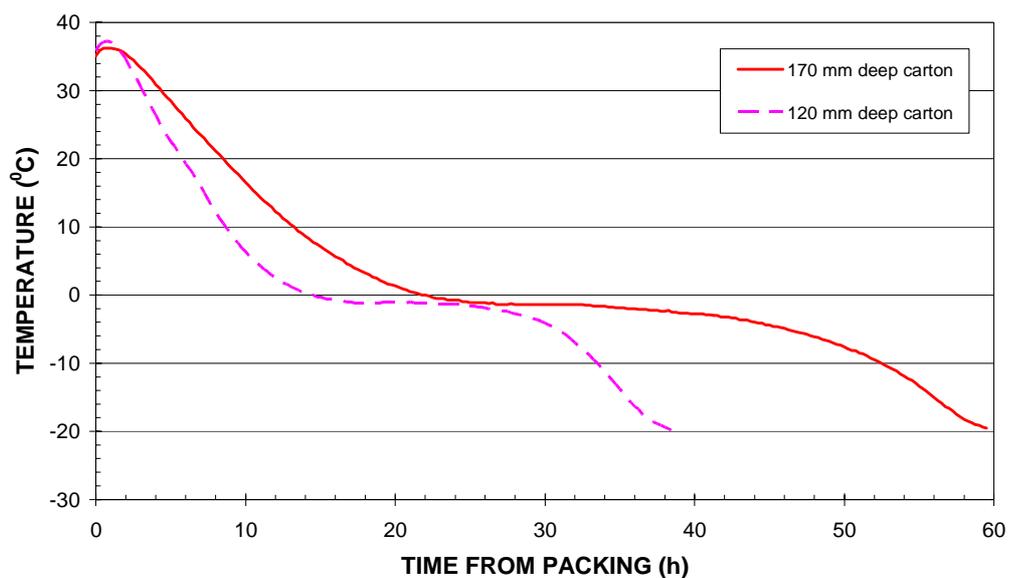


Figure 1. Effect of carton depth on freezing rate in a blast freezer

products. It is the custom in most plants to pack products such as beef hearts and cheek meat into 27.2 kg cartons, while most other offals such as livers, tongues, kidneys, etc. are packed into smaller cartons.

CSIRO undertook several offal-chilling trials some years ago. In one trial in a batch blast freezer operating at -30°C (Figure 1), beef livers packed in 120 mm-deep cartons cooled to 7°C about 5 hours sooner than when packed in 170 mm-deep cartons. The refrigeration index for the livers packed in the small cartons was calculated at 2.5, compared with the value of 4.2 for those packed in the large cartons. Similar results were achieved with hearts. In this particular freezer a carton depth of 110 mm, or some cooling before packing, may have been advisable to more reliably achieve a satisfactory index. The use of shallower cartons resulted in shorter freezing times so that the product was reliably frozen within a 48-hour cycle.

Packing temperature

It is important that the packed cartons are placed promptly under active refrigeration. Delays will lead to rapid growth of bacteria. Bacteria numbers can increase rapidly at temperatures between 30°C and 40°C. For instance, at a temperature of 35°C, the number of *E. coli* doubles every 20 minutes or so; whereas, at 25°C, the time increases to about 45 minutes. The temperatures of products such as beef hearts and livers are often at about 35°C when the cartons are packed; whereas others, such as tails and cheek meat, are closer to 25°C.

Under the same cooling conditions, the product packed at the lower temperature will reach 7°C sooner than hotter product, resulting in less opportunity for growth of *E. coli* and other undesirable bacteria—as reflected by a lower refrigeration index.

In Figure 2, the carton of cheeks packed at a temperature of 26.5°C cooled at a rate similar to the hearts packed at 35°C, but the refrigeration index was 0.5 compared with an unacceptable 3.2 for the hearts.

Type of freezer

The heat transfer coefficient in a plate freezer is about three times that of a blast freezer operating at an air velocity of 3 m/s. This higher heat transfer, combined with a plate temperature that is normally lower than the air temperature in a blast freezer, results in much more rapid cooling in a plate freezer. A 24-hour cycle is normal in plate freezers whereas a 48-hour cycle is required for blast freezing.

Importantly, the initial cooling rate is also faster in the plate freezer. The cartoned cheek meat considered in Figure 3 was packed in 155 mm deep cartons. The refrigeration index was 0.7 in the plate freezer compared with 1.8 in the blast freezer.

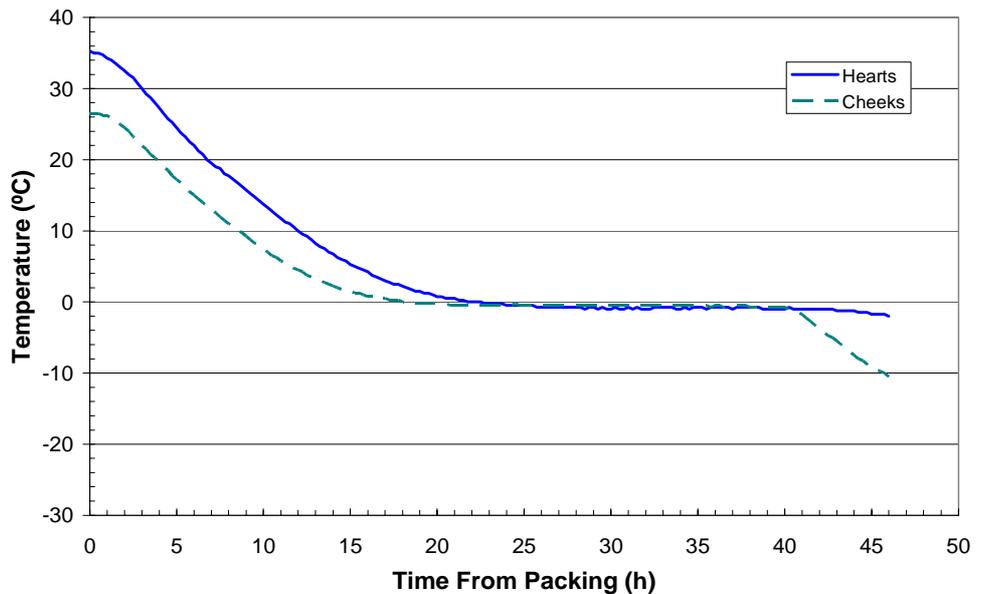


Figure 2. Effect of packing temperature on cooling time in a blast freezer

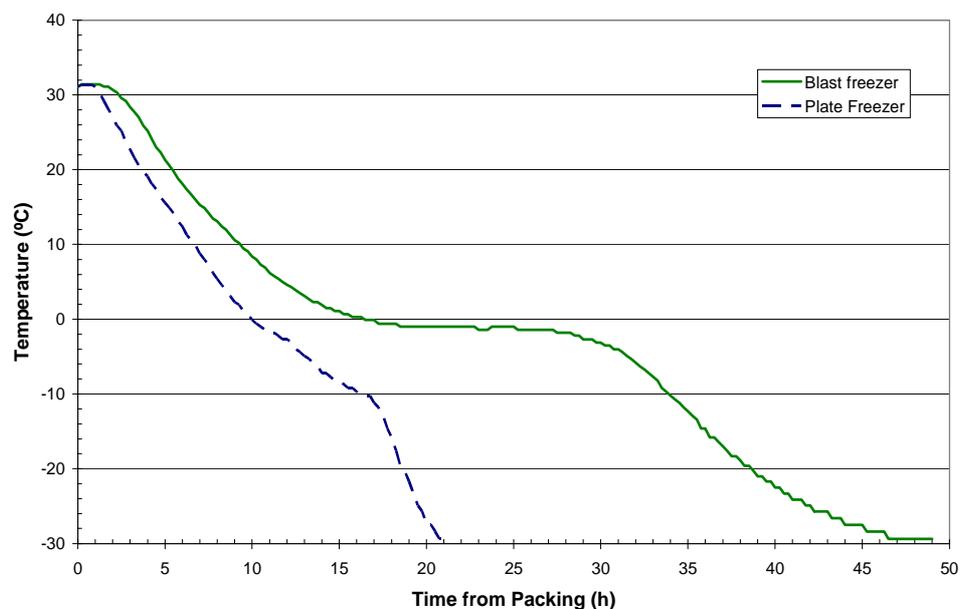


Figure 3. Plate freezing versus air-blast freezing

Pre-chilling

An effective technique for meeting the refrigeration index for products such as hearts and livers that are packed into deep cartons is to pre-cool them to below 25°C before packing. Two methods that could be used are air cooling and immersion cooling. Both add cost and additional handling to the process, but may be preferable to the installation of a plate freezer or use of smaller cartons.

Air cooling can be done on racked trays in a static chiller, on trays in a push-through trolley tunnel or on hooks or trays conveyed through a chiller. Air at a temperature of 0°C to 5°C and a velocity of 1 m/s will reduce a large (7 kg) liver to an average temperature below 25°C within about one hour. The disadvantage of air blast chilling is the evaporative and

draining weight loss of the order of 0.5 to 1.0%. Some surface drying and darkening occurs, but this is not noticeable after freezing and thawing.

Large offal items can be cooled continuously in gently agitated chilled water at about 2°C. Beef livers are the slowest cooling item and take around 30 minutes to reach a mean temperature of 25°C. Chillers can be modelled on the spin chillers used for poultry. These are a horizontal semi-circular vessel with the product conveyed by an auger rotating at a speed to give the required residence time. In some New Zealand trials, weight gains of 2 to 3% were recorded which, unless allowed to drain, could require declaration on the label for some markets. Water chilling can lead to surface wrinkling; but, after freezing and thawing, livers are indistinguishable from conventionally frozen product.

For additional details on pre-chilling refer to AMT Information Package (1997) 'Chilling of Hot Offal Prior to Packing'.

Dry ice

Cooling of beef hearts in deep cartons can be hastened by the addition of carbon dioxide in the form of either pellets or snow. The carton is packed to the set weight, then CO₂ pellets or snow is added near the centre before closing the carton. This results in an immediate drop in temperature near the centre of the carton followed by an equilibration. In the trial that is illustrated in Figure 4, the improvement in cooling rate using 1 kg of dry ice pellets reduced the refrigeration index from an unacceptable value of 3.8 to 0.3, although overall freezing time was not improved. The cost of dry ice was in the region of \$0.50 per carton. The quantity of CO₂ required to achieve the desired Refrigeration Index for a particular application can be determined by trials.

Scalded tripe

Tripe products that are partly cooked should be cooled down before they are packed. The temperature of scalded tripe could be 40–50°C on discharge from the tripe washer. In one test, tripe packed at 44°C and cooled in an air-blast freezer at an air temperature of –33°C had a RI of 2.9. Tripe should be cooled to 35°C or lower by leaving them in the cold water rinse in the tripe washer for a sufficient time, or by cooling them on trays before packing them.

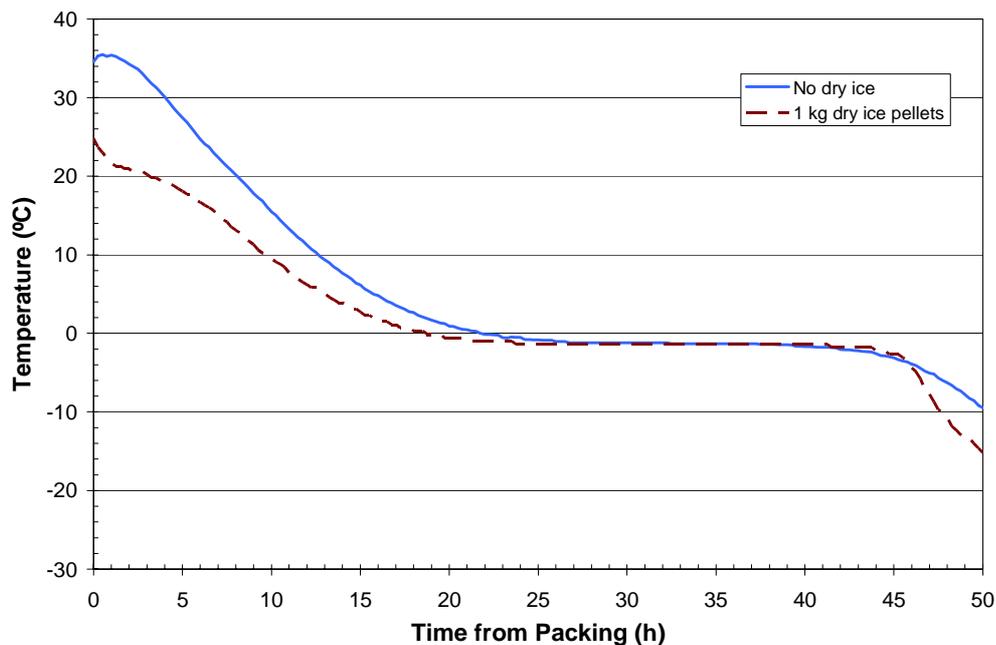


Figure 4. Effect of dry ice on hearts when freezing in a 27.2 kg carton

Recommended practice

Packing

The size of the carton should be selected mainly on the basis of the temperature at which the product is packed. The carton should be shallow enough to ensure that the refrigeration index is met for the type of freezer used, and that the product is fully frozen when it is unloaded.

- Cartons for offals packed at 30°C and higher should be not greater than 110 mm deep, and for offals packed at 15°C to 30°C not greater than 155 mm deep.
- The interval between completion of packing a carton and placing into an active freezer should be less than 15 minutes.

Freezing

The depth of the carton and the type of freezer used are the main factors affecting the rate of cooling of the product. In order to meet the refrigeration index, the optimum combination of carton depth and freezer type must be used for the product packing temperature.

- Product packed at above 30°C in cartons up to 155 mm deep should be frozen in a plate freezer which has the facility to close each shelf after it has been filled.
- Product packed at a temperature below 30°C in cartons up to 155 mm deep may be frozen in blast freezers using air at –25°C or colder and an air velocity of at least 3 m/s.

Freezing guide

This guide summarises the recommended maximum-product-packing temperatures for different carton depths and freezing systems.

Packing temperatures and carton depths (mm) for various freezing systems

Initial Temp (°C)	Plate Freezer (-35°C)			Continuous Blast Freezer (-30°C, 3 m/s)			Batch Blast Freezer (-25°C, 1.5 m/s)		
	<110	110-150	150-170	<110	110-150	150-170	<110	110-150	150-170
25	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
26	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
27	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
28	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
29	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Orange
30	Yellow	Yellow	Yellow	Yellow	Yellow	Orange	Yellow	Orange	Orange
31	Yellow	Yellow	Yellow	Yellow	Orange	Orange	Yellow	Orange	Red
32	Yellow	Yellow	Orange	Yellow	Orange	Orange	Yellow	Red	Red
33	Yellow	Orange	Orange	Yellow	Orange	Red	Yellow	Red	Red
34	Yellow	Orange	Red	Yellow	Red	Red	Orange	Red	Red
35	Yellow	Orange	Red	Yellow	Red	Red	Orange	Red	Red
36	Yellow	Red	Red	Orange	Red	Red	Orange	Red	Red
37	Yellow	Red	Red	Orange	Red	Red	Red	Red	Red
38	Yellow	Red	Red	Orange	Red	Red	Red	Red	Red

- Packing temperatures that should meet the refrigeration index
- Packing temperatures that may meet the refrigeration index
- Packing temperatures that are unlikely to meet the refrigeration index

The application of about 1 kg (or suitable quantity) of dry ice to the centre of deep cartons should ensure that they also meet the refrigeration index.

The information contained herein is an outline only and should not be relied on in place of professional advice on any specific matter.

For more information, contact one of the Meat Industry Services staff listed below.

Food Science Australia Meat Industry Services

Meat Industry Services (MIS) of Food Science Australia is an initiative supported by Meat and Livestock Australia (MLA) and the Australian Meat Processor Corporation (AMPC) to facilitate market access for, and support world-class practices in, Australia's meat industry.

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