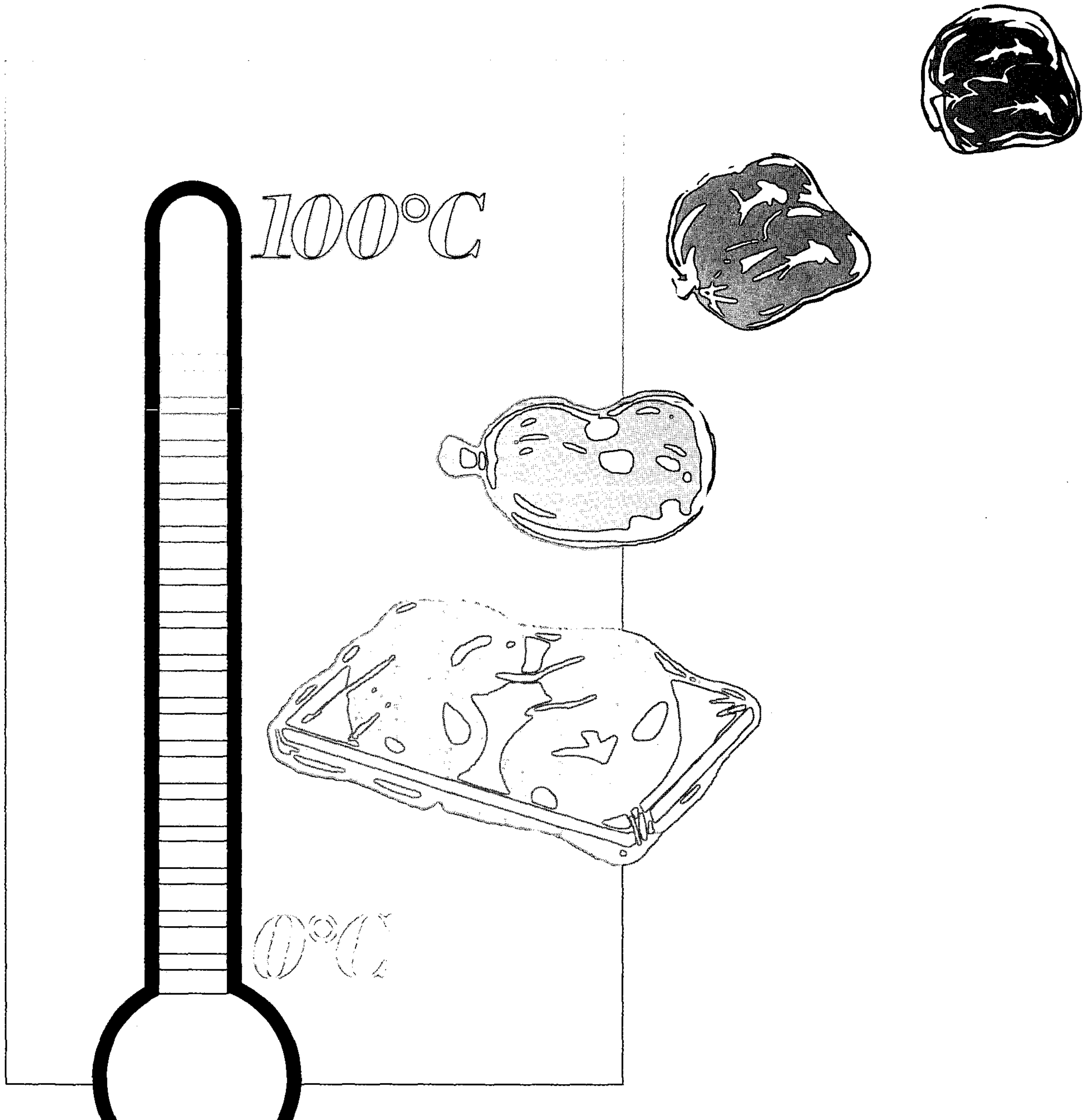

Chilling of Hot Offal Prior to Packing

1997

Meat Research Corporation

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AUSTRALIAN MEAT TECHNOLOGY

Water chilling, air-blast chilling and cryogenic cooling methods are three methods processors can use to comply with suggested satisfactory manufacturing practice of pre-cooling offal prior to packing. Research shows that these three methods can result in lower microbial growths than current practices used for the freezing of hot offal in cartons – providing there is adequate air movement (in the case of air-blast chilling) and an appropriate temperature.

Because specific requirements for the chilling of hot offal do not exist, AQIS cooling requirements for hot-boned meat (Table 1) have been suggested as satisfactory practice. AQIS cooling requirements for hot-boned meat have been suggested as best practice for three primary reasons:

1. Individual bare offal are often tightly stacked on cooling hooks with surfaces touching.
2. Some smaller offal are pre-chilled in trays and on racks with surfaces touching within the layer of product.
3. Some offal may be individually wrapped prior to pre-chilling.

When considering frozen product, meeting suggested best practice can be achieved by:

- Reducing the carton "starting" temperature prior to commencement of freezing (some form of pre-chilling of offal prior to packing is required) as discussed in this brochure
- Packing the offal into sufficiently thin cartons to allow compliance by air blast or plate freezing
- Packing offal into thinner inner packs to be blast chilled or blast frozen (air-blast, plate or cryogenics) before packing into "standard" meat cartons followed by finish freezing or freezer storage
- Packing hot offal into "standard" cartons together with sufficient cryogenic refrigerant followed by conventional air blast freezing

Table 1 – Suggested time/temperatures for offal

Offal initial temperature	Time in minutes to fall to 7°C
39	386
38	399
37	414
36	431
35	450
34	468
33	486
32	505
31	525
30	547
29	568
28	593
27	620
26	651
25	683
24	720
23	760
22	805
21	854

Note: *Because the cooling rates in Table 1 are relevant to hot moist surfaces (eg in cartons), the rates may be considered too stringent for air-chilled, bare offal where surface drying gives additional benefits in limiting microbial growth. There are other circumstances – microbiologically "clean" offal to start with – where the rates may also be unnecessarily stringent.*

Table 1 assumes pathogens will behave similarly on the surfaces of offal as on the surfaces of meat, and that offal removed from the carcases on the slaughter floor is packed and placed under further refrigeration within an hour of removal from the carcase. The product is subsequently subjected to a continuous fall in surface temperature in order to restrict the increase in *E.coli* numbers to an overall maximum of 1 $\log_{10}$ increase.

This is accomplished by cooling the surface temperatures to below 7°C within the times specified or, in the case of closely packed items, the time to reach 7°C at the thermal centre of the package. Initial offal temperature and starting time measured at a maximum of one hour after removal from the carcase.

Water Chilling

According to a CSIRO Research Report, a 5.45kg beef liver which was vacuum-packed hot can be cooled from 37°C to 7°C within 4.5 hours when placed in an ice/water bath. This time is well within the AQIS cooling rate for hot-boned meat. (The report does not provide, however, information pertaining to appearance of the bag in relation to drip and tightness, and the report does not state if the iced water was agitated.)

The cooling rates for various bare offal placed in gently agitated 2°C water are given in Figure 1. These comply with the AQIS cooling requirements for hot-boned meat.

Water chilling takes advantage of the higher heat transfer coefficient of offal in water vs air – up to 10 times higher. But, since the thermal conductivity of the product is fixed, the reduced cooling time advantages of water chilling compared to air chilling of larger offal – such as livers – are less pronounced. (Compare Figure 1 with Figure 2.)

Figure 1: Smoothed experimental cooling curves for lamb and beef edible offal immersed in gently agitated 2°C water. Bacterial growth numbers (generations) in brackets.

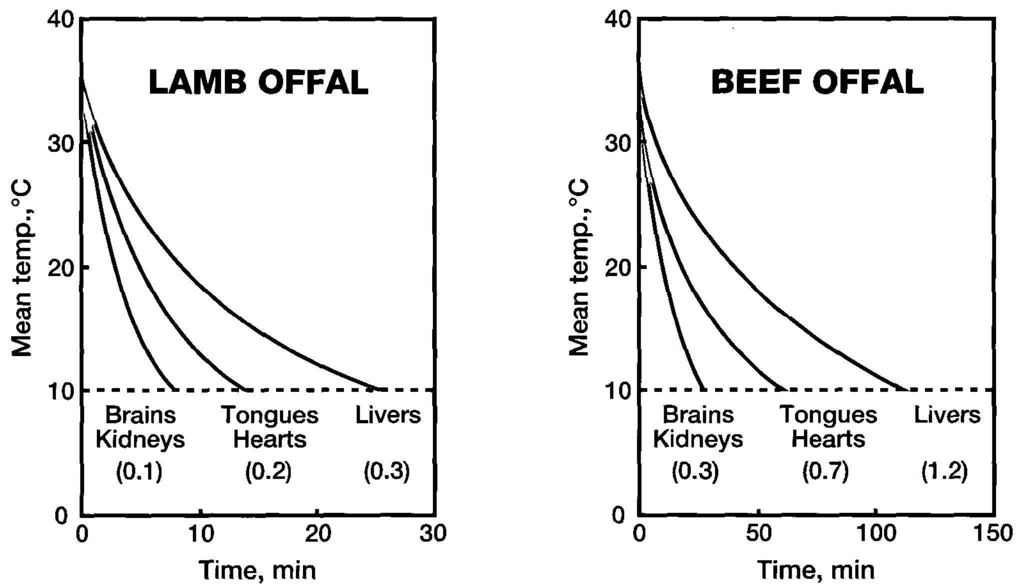
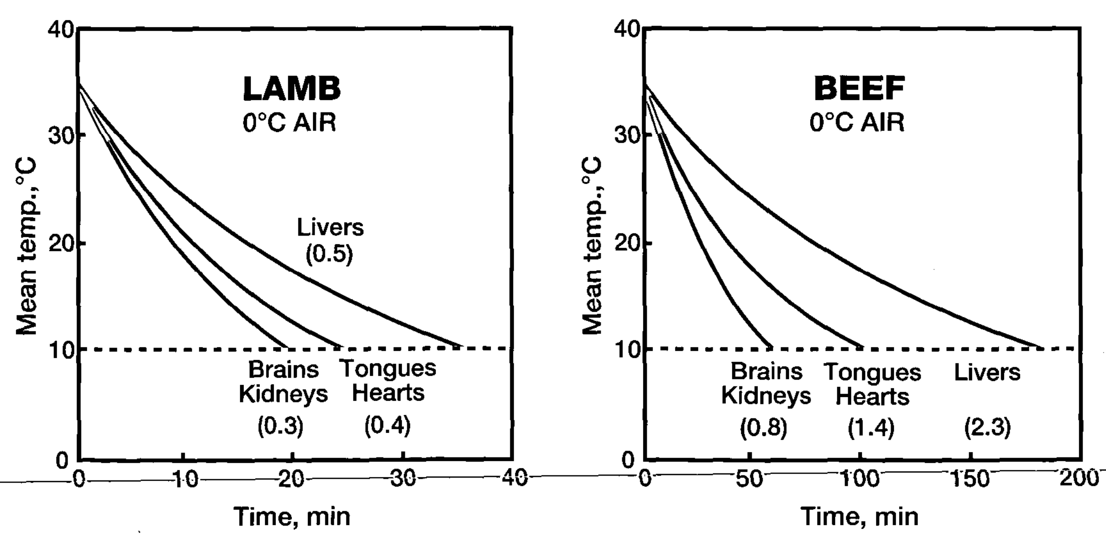


Figure 2: Smoothed experimental cooling curves for bare individual lamb and beef offal with 0°C air temperature and 3m/s air velocity. Bacterial growth numbers (generations) in brackets.



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Water pre-chilling can lead to surface wrinkling and some loss of colour. After freezing and thawing, however, offal are indistinguishable from conventionally frozen product.

In some New Zealand trials, offal typically gained 2%-3% in weight. (The time periods of immersion are not given,and it is not known whether the offal were removed from the bath as soon as they reached a 10°C mean temperature or after much longer periods.)

With any pre-chilling system, a "first-in first-out" feature is desirable to achieve consistent results. Product flow during the chilling of offal within mesh baskets in static tanks needs careful control to ensure each offal receives sufficient pre-chill time.

Based on poultry experience, each 1kg of product requires 1.3kg of water (to be dumped to waste) to maintain "hygienic" conditions in the water bath.

Spin chillers from the poultry industry are an ideal way of ensuring a first-in first-out regime. However, spin chillers are costly and their performance on thin meat sections, such as cheek meat or skirt, are unknown. (They may bind in the screw flights). These offal may be successfully chilled in air on trays prior to packing.

A less costly option is to manufacture simple, belt pre-chillers using a plastic intralox-type belt in a stainless steel tank. The belt option may be impractical, however, due to the retention times needed for large offal such as beef livers.

Spin chillers could be used in conjunction with ice storage "banks" which would allow ice to be made on off-peak electricity and reduce running costs. This practice, however, will incur additional capital costs, but these costs could be partially offset by the reduction in the refrigeration plant capacity required.

Air-Blast Cooling

In the domestic industry, existing carcase chillers or offal chillers are commonly used to pre-chill bare offal to an internal temperature of 5°C prior to load-out chilled.

Larger plants have two additional pre-cooling options:

- Fully pre-chill bare individual offal to a state where the offal will equilibrate to 10°C after removal from the pre-chiller and packing, then finish chilling or freezing conventionally
- Pre-chill in say 80mm-deep metal trays to a mean temperature of 10°C, then finish chilling or freezing conventionally after packing

In both cases, the most economical option is either push-through manual or conveyorised "trolley" type blast chillers.

Blast chilling bare offal causes surface drying and darkening. Once frozen and thawed, however, blast chilled offal is reportedly indistinguishable from conventionally frozen offal. Blast chilling of bare offal leads to weight losses of 0.5% to 1%. (Some weight loss can also be expected from offal in open-topped metal trays.)

Air-blast chilling of bare offal may be accomplished in spiral-type units (commonly used as freezers for hamburger patties). A downside of this, however, is contamination of the belt due to drip which may cause hygiene problems.

In New Zealand trials, crust freezing of bare offal using sub-zero temperatures during initial cooling was not a problem – except for beef livers which had to be left to equalise and soften prior to packing.

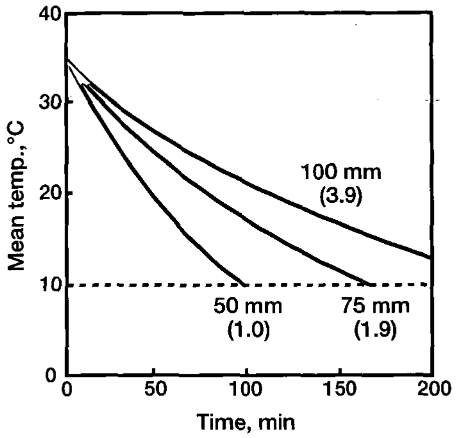
Figure 2 shows the cooling rates for bare beef and lamb offal in air temperature of 0°C and an air velocity of 3m/s. It appears these cooling rates will satisfy the AQIS cooling rates for hot-boned meat.

Predicted cooling curves for bare offal in open-topped metal trays of various thicknesses, with an air temperature of -5°C and an air velocity of 3m/s, are indicated in Figure 3. AQIS cooling requirements for hot-boned meat can be met except in the case of 100mm trays.

Spiral air-blast chillers give continuous operation and a first-in first-out feature for bare offal. A disadvantage of spiral air-blast chillers is the cost which is extremely high.

Continuous chillers also require separate runs with different residence times for the different

Figure 3: Predicted cooling curves for offal in metal trays packed 50, 75 and 100 mm deep and cooled in an air-blast chiller having a -5°C air temperature and an air velocity of 3m/s. Bacterial growth numbers (generations) in brackets.



sizes of offal. This requires offal to be held back, causing undesirable delays prior to cooling. On the other hand, chilling a mixture of offal is not practical because offal discharge temperatures differ depending on the size of the offal, and it is also more labour intensive as offal must be sorted before packing.

The most cost-effective solution: chilling sorted offal on trays in a trolley chiller.

Note that the air-blast chiller would be emptied daily and the product packed into outer cartons and finally chilled or frozen conventionally.

Cryogenic Cooling

With cryogenic cooling, processors have the option of chilling offal bare, either individually or in trays. Simple cryogenic tunnels employing carbon dioxide (-60°C) or liquid nitrogen (-80°C) result in very rapid cooling rates with negligible bacterial growth.

Crust freezing of individual offal requires some equilibration time to allow offal to soften sufficiently for packing.

In cryogenic tunnel trials, belt indentation markings were visible in individually chilled offal after thawing. Softer offal, such as brains and kidneys, stuck to the belt resulting in surface damage. Chilling in trays eliminated such problems.

Cryogenic cooling is more costly than other alternatives.

Additional information

"Chilling and Holding Cartoned Meats", CSIRO, Workshop Proceedings, Production of Chilled Meat for Export, 1991

"Evaluation of Hygienic Efficiency of Offal Cooling Procedures", Food Microbiology, 1985, Vol. 2, p. 63-69

"The Effect of Cooling Rate on the Microbiological Status of Internal Tissues of Beef Liver", CSIRO, Meat Research Report 10/77

Australian Meat Technology Pty Ltd Training Manual, "Food Safety – Hygienic Meat Made Even Better!", 1996

Additional information

Additional help and advice are available from Food Science Australia, Meat Industry Services Section:

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