Meat technology update

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Bulk-packed frozen meat for further processing: alternatives to current practice

Much of the beef and mutton that is bulk-packed to CL specifications and frozen for distribution to Australian or overseas customers for grinding or other reduction procedures, is packed in 27.2 kg cartons. This article considers some alternative procedures that promise greater efficiency, reduced costs, better returns and other benefits.

Broadly, bovine and ovine carcases are deboned into primal cuts that are sold either chilled (mostly in vacuum packs) or frozen; and trims that are sold for further processing. Quantities of beef and mutton produced annually in Australia and New Zealand and destined for grinding, either locally or overseas, total around one million tonnes. Of that, upwards of 700,000 tonnes is exported, virtually all frozen.

Current process

Current procedures for packing and handling cartons of meat (that is bulk-packed to chemical lean (CL) specifications for grinding) are labour-intensive. In many establishments, tasks requiring manual labour include slicing/trimming, sorting, carton erection, packing, lidding, loading into and unloading from freezers, and transfer to shipping containers or trucks for transport. Under the current system, the labour and packaging materials costs incurred by processors for sorting, packing cartons, freezing and loading-out beef trims for shipment are in the range $0.20 to $0.30 per kg. While some tasks have been automated in larger plants—notably carton erection, carton closure, monitoring for CL content and freezing—other tasks continue to require manual labour.

Carton handling injuries are a significant reason for OH&S claims. Other notable problems are inconsistency in CL content and polythene entrapment. These are costing money in that better prices can be obtained for product that consistently meets specification and in which there is no entrapment to hinder the unwrapping of the frozen blocks by the customer.

In 2007 a study was commenced to demonstrate that financial returns to Australian meat processors can be improved by implementing processing, handling and transport procedures for manufacturing beef and mutton that cost less than the current labour-intensive ones, *and attract price premiums* . This article provides information from that study.

Alternative processes

For some years there has been interest in introducing procedures for freezing, storing and transporting manufacturing beef and mutton that promise advantages over the current procedure. As an example, an industry-funded project (PSHIP.084) was undertaken in 2001 at Oakey Abattoir, based upon freezing large blocks of beef trimmings in a vertical plate freezer. Beef trims were loaded into a prototype vertical plate freezer fitted with stainless steel plates which produced 72 mm thick blocks approximately 1020 mm x 1020 mm. These were frozen to –18°C in just over 2 hours using ammonia. After discharge, the blocks were cut into 6 sections and palletised. The pallet load of approximately 1 tonne was packaged in polyethylene and fibreboard. Some issues with this system included: difficulty in loading meat into the narrow slot; condensation from the defrost cycle incorporated to release the meat prior to unloading; and difficulty in cleanly cutting the frozen blocks. Information reported to AMPC and MLA on this project was considered in 2007 by a project team which again investigated the merits of freezing trims before the meat is packaged.

During the 2007–08 investigation, the following aspects of the process were considered:

- most appropriate freezer type for preparing frozen blocks;
- preferred size(s) of frozen meat blocks;
- meat piece size;
- advantages and disadvantages of trays/moulds for freezing;
- suitable equipment for filling meat pieces into moulds or plates;
- need for trays to be lidded or covered to enter plate freezer;
- suitable means of removing frozen block from mould;
- suitable handling mechanism for frozen blocks;
- packaging palletised blocks.

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Trials were undertaken in collaboration with Keystone Foods (the key grinder participant in the study), to establish parameters for meat-piece-size reduction, freezing, and mould filling and emptying. The team determined that acceptable size reduction and transfer of meat pieces could be achieved using a grinder and a vane-type meat pump fitted with a fan-shaped nozzle. Freezing investigations showed that, using ammonia as the refrigerant, the meat could be cooled to –18°C within 1.8 hours of loading 60 mm deep trays into a freezer.

As well as systems already available for food in Australia and New Zealand, existing systems in Europe for freezing fish and chicken products were considered by the team. Slabs of meat 75 mm thick can be cooled to -18°C within 2 hours using either vertical or horizontal plates if CO_2 is used as the refrigerant (slightly longer with ammonia as the refrigerant), permitting several freezing cycles per day. The most suitable freezers for the process were determined to be automatic horizontal plate freezers because they did not share hygiene and other challenges previously experienced with vertical plates. Based on European experience, plastic trays were nominated as the preferred moulds in which to freeze the blocks. If freezers with aluminium plates were to be chosen, the trays would need lids.

In most establishments, forming slabs as thin as 75 mm (i.e. approximately half the depth of current cartons) requires some size reduction of beef trims and horizontal freezer moulds are necessary. Trials were undertaken by the project team to establish procedures for meat-piece-size reduction, and mould filling and emptying.

The fully commercial system is likely to include the following features: mechanical size reduction to facilitate automatic loading of re-usable trays to their target weight; automatic loading and unloading of trays into and from the plate freezer; automatic removal of frozen meat from trays; and automatic palletising and wrapping of shipping units weighing (probably) one tonne. The wrapped units will be loaded directly into shipping containers for export. The size of the tray will likely be selected so that two frozen blocks have approximately the same dimensions as meat packed into a normal carton. This provides a pallet module that is compatible with refrigerated shipping containers and allows the blocks to be packed in conventional cartons (if required for particular markets).

In addition to the cost savings and likely premium prices resulting from avoidance of polythene entrapment in frozen meat and improved consistency of CL content, the very rapid freezing promises possible improvement in the functional properties of the meat for making patties and other processing purposes.

A system layout was prepared and costed. Current carton packing, freezing and handling procedures at plants were also costed. For systems of new equipment in an existing facility which is extensively mechanised to minimise labour requirements, and with stand-alone refrigeration compressors, the establishment cost for an alternate system capable of processing and freezing 30-40 tonnes per day was estimated to be around $2 million, not including building requirements. Some plants could achieve cost reductions of around $0.17 per kg.

When compared with the labour and packaging costs currently incurred by processors, there will be cost savings. In addition, a price premium might be expected. The net benefit would be up to $3,800 per 20 ft container. Other benefits include: the small floor space required; likely improved functionality for making beef patties; and reduced risk of microbial contamination. The system offers opportunities to introduce microbiological interventions such as conveyor pasteurisation and meat decontamination processes that are not practical with the current manual carton-packing and freezing procedure.

To the end of June 2008, 34 Australian establishments each exported in excess of 4,000 tonnes of beef or mutton per annum (approximately 600 cartons per day) for manufacturing; an aggregate of well over 350,000 tonnes. There were also around 30 New Zealand establishments producing 600 or more cartons per day of manufacturing meat for export. The project team was of the opinion that these establishments would all be able to realise net financial benefits from the introduction of the proposed system. There would also be benefits for product destined for domestic processing.

Figure 1: Assembled pallet of blocks

Trial shipment

In 2008, stakeholders agreed that consignments of frozen blocks be prepared manually and sent to Australian and US grinders to gain their feedback, and to seek formal reaction from regulatory authorities. For each of two consignments, frozen blocks were stacked to give shipping unit weights of almost one tonne, wrapped with stretch film and enclosed in a two-layer fabric of woven polypropylene which was coated on the inside with a polythene/polypropylene co-polymer (Figures 1 and 2).

The first consignment (4.9 tonnes) was received by a grinder in Queensland and evaluated there at intervals over 13 weeks. There was minor discolouration of some blocks where the polyethylene combo bag used as secondary protection beneath the woven polypropylene outer had not been in close contact with the meat, but the outturn was acceptable in appearance, and in functional and sensory properties.

Figure 2: Stretch wrapping pallet

A larger (19.4-tonne) consignment of blocks was shipped to the USA (Figure 3) and re-inspected in New Jersey in December 2008. Alternative ways for USDA re-inspection to occur were discussed with AQIS and FSIS during the re-inspection. Prior to the actual re-inspection FSIS feared that the new packaging format would involve FSIS inspection staff in additional work. In fact the removal of the packaging, accessing the blocks that were randomly selected using the FSIS automated import information system for sampling, and reassembling and resealing the shipping units all proceeded smoothly. FSIS inspection staff and freezer-store staff all commented enthusiastically about the ease of sampling the consignment.

Senior FSIS and AQIS personnel were present for the re-inspection. It is anticipated that the re-inspection will lead, in due course, to USDA agreeing to some amendments to its re-inspection procedure along the lines proposed by AQIS; however, the existing inspection procedure proved to be practicable for the consignment and would be suitable for ongoing consignments.

From New Jersey, the consignment was trucked to Keystone Foods, North Baltimore Ohio. Some of the shipping units were opened and ground in early December. Immediately after blocks had been ground (6 weeks after being prepared in Queensland), patties of blended US chilled and Australian frozen beef from the trial consignment were cooked in the company test kitchen. The flavour was determined by staff there to be good with no off-flavour. Other shipping units were put into frozen storage and have been ground at intervals since. Sensory assessments of the ground beef and patties have gone well to date.

The trial provided valuable information on regulator and end-user responses. It demonstrated that the one-tonne shipping units are compatible with current re-inspection and end-user grinding practices, and gave Australian stakeholders confidence that the one-tonne shipping units are acceptable to US stakeholders.

The shipping unit

A key feature of the approach is that the unit that carries the label is of the order of one tonne instead of a 27.2 kg carton. There is, no doubt, a variety of packaging options that would adequately protect the meat. In the trial described above, the polypropylene covers generally worked well. The only difficulty encountered was fitting the covers when the blocks were not evenly stacked. The reactions to the packaging were favourable from packing staff in Australia, as well as inspectors and handlers in the US. At the time of re-inspection, the tops proved relatively easy to remove and replace, and, at the grinding facility, they were found very convenient to remove and stow for disposal. Whilst some possible modifications were identified, all stakeholders agreed that the commercial shipments could proceed with this form of packaging, but other packaging (such as fibreboard) may also be suitable. The cost of this packaging, with integral slip-sheet, will be around AUD17.50 per tonne for one-tonne units. This compares with around AUD35 to 45 per tonne when cartons and liners are used. Currently the polypropylene outer cover is a disposable, but recyclable, item.

Figure 3: Finished units loaded into container for shipping to the USA

This packaging approach has additional benefits for the grinder including less waste to dispose of, no polythene entrapment, a lighter, easier-to-handle block and more consistent CL.

Envisaged commercial installation

System layouts that would mechanically produce unitised frozen meat blocks (UFMB) in quantities ranging from 4.5 metric tonnes per day (one shift) to 40 MT (two shifts) that could be loaded out directly into shipping containers, have been considered. Throughput could be further increased by duplicating the freezer, and/or by installing a larger freezer (up to 150 tonnes per day).

In an existing facility, the establishment cost is dependent on throughput, level of mechanisation, availability of refrigeration capacity and whether equipment that is installed is new or used, and whether (future) provision is made for in-line CL analysis.

Ideally product of a specified chemical lean will be prepared by measuring the CL of two meat streams on-line, and blending them to meet the desired specification prior to freezing. The CL of the streams can be measured by X-ray or spectroscopic technology. Alternatively the CL of the blocks could be measured on-line after freezing, and the one-tonne unit labelled accordingly.

The floor area required for the systems, including palletising of frozen blocks, is around 150–175 m^2.

MLA has recently commissioned a study—in which processors, transporters, import cold stores and grinding companies were consulted—to understand the net benefits of the technology and to quantify the value of a commercial system for the various supply-chain participants. The study identified the decisions a processor would need to consider in determining the benefit of the technology to its business. It considered a range of investment scenarios based on employing either an existing plate freezer operating on a 24-hour cycle, or purchasing a specialised naked-block plate freezer with a 2-hour cycle. As Table 1 shows, for a plant processing 1,500 head per day, an attractive return on investment is achievable provided the system can be easily incorporated into the existing trim sorting arrangement and plant layout. The use of an existing plate freezer is attractive provided sufficient capacity is available and the meat is packed into moulds to the same depth as 27.2 kg cartons. US import inspection houses and grinding companies would also benefit, but to a smaller extent.

Establishment of a centralised naked-block plant to serve several processors was not considered to be a viable option mainly due to the cost of bulk bins and CO_2 snow.

US Customs duty

US Customs broker advice has been received that applicable duty will remain the same as current manufacturing beef. While a formal submission has been made to US Customs, a formal response has not yet been received.

Acknowledgement

Prior to the commencement of the project, a project steering group—members of which included representatives from five export-registered processors, McDonald's Asia-Pacific Consortium (Mac), AMIC, MLA, AMPC, AQIS, FSIS, AUS-MEAT and FSA—was established. The project team was drawn mainly from this steering group.

Further reading

MLA report A.TEC.0068: Quantifying the value proposition to the Australian beef industry of freezing and transporting frozen trimmings without a carton: naked block project cost review, September 2009.

MLA project report A.TEC.0056: Frozen meat for manufacturing —alternative process for handling and packaging, May 2008.

MLA project report A.TEC.0067: Frozen beef—preliminary consignment, February 2009.

Table 1: Estimated processor return on investment scenarios

	Scenario	Payback (yrs)	CAPEX (Mill)
1.	Existing plate (easy trim sort & easy tub transfer)	0.6	$1.3
2.	Existing plate (easy trim sort & extra tub transfer capex)	2.5	$4.5
3.	Existing plate (difficult trim sort, re-furb & easy tub transfer)	1.3	$2.4
4.	Existing plate (difficult trim sort, re-furb & extra tub transfer capex)	3.8	$5.6
5.	Existing plate (difficult trim sort, no re-furb & easy tub transfer)	1.4	$1.3
6.	Existing plate (difficult trim sort, no re-furb & extra tub transfer capex)	14.7	$5.6
7.	NB plate (easy trim sort, offsite frz saving & NB cold store capex)	1.1	$5.4
8.	NB plate (easy trim sort, no offsite frz saving & exist cold store)	2.5	$4.2
9.	NB plate (easy trim sort, no offsite frz saving & NB cold store capex)	4.1	$5.9
10.	NB plate (difficult trim sort, re-furb, offsite frz saving & exist cold store)	1.4	$6.7
11.	NB plate (difficult trim sort, re-furb, no offsite frz saving & exist cold store)	4.1	$5.5
12.	NB plate (difficult trim sort, re-furb, no offsite frz saving & NB cold store capex)	6.4	$7.2
13.	NB plate (difficult trim sort, no re-furb, no offsite frz saving & exist cold store)	10.3	$4.2
14.	NB plate (difficult trim sort, no re-furb, no offsite frz saving & NB cold store capex)	29.8	$5.9

Contact us for additional information

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