MEAT TECHNOLOGY UPDATE
Cutting edge technology for the meat processing industry

Meat technology update

3/09 – June 2009

40 years of Meat Industry Services

Forty years ago, in 1969, a small shipment of Australian vacuum-packed chilled meat was sent to Japan. This small consignment heralded the beginning of new and emerging market opportunities for Australian chilled meat into Asia, Europe and the United States of America. Today, Australian meat processors export chilled and frozen meat to over 100 countries worldwide, and have annual earnings of over $6 billion; but this substantial market did not develop overnight, and, with the assistance of the MIS scientific and technical staff, the meat processors have overcome significant challenges and setbacks.

It was the initial need to address hygiene and quality issues, which led to the Australian Meat Board and CSIRO gathering a team of scientists and technical experts to assist the meat processing industry to meet the markets' concerns. The **Meat Industry Services** (MIS) section was established and the immediate challenges were: eliminating visual defects for the US market; determining chilled storage life for the Japanese markets; and the elimination of *Salmonella* for Sweden.

June 2009 marks 40 years of scientific and technical input by the Meat Industry Services group and significant challenges have been overcome in this time. Processing practices that seem second nature today, were not a consideration when these markets were being established forty years ago.

Since its inception, MIS has responded to well over 50,000 enquiries, published over 250 technical newsletters and 225 research reports, and conducted 45 series of industry-specific workshops and seminars (including the publishing of the relevant papers and proceedings). MIS continues to feed research outcomes back to members of the meat processing industry, allowing them to maintain their position at the forefront of quality meat production; and assisting processors to address issues that continue to impact on their markets.

Forty years ago, the initial emphasis was on the improvement of carcase and equipment hygiene. Soon, though, vacuum packaging, lean meat (CL) testing and other technical issues became important. Many topics have been addressed by Meat Industry Services over the years and some of these issues continue to generate enquiries; but the circumstances and the nature of most information sought now, is in meeting the exacting standards demanded by importing countries in relation to microbiological quality. The maintenance and continuous improvement in the hygienic quality of meat product continues to be the main focus within MIS and the meat processing industry.

Figure 1: MIS technical staff monitoring carcase hygiene

The meat processing industry is fortunate in that MIS holds a unique position within CSIRO: as an integral part of the CSIRO network, it is able to facilitate co-operation between processors and any number of internationally recognised scientists to address a range of issues that may confront individual processors. Through the CSIRO network, a 'big picture' approach to industry concerns is feasible and, what's more, has been proven to work!

Carcase hygiene and interventions

Much of the early work of MIS focussed on the hygienic production of meat and included the assessment of chemicals for cleaning and advice to industry on cleaning procedures—the first MIS technical report, (1/70) being on carcase hygiene, and the first workshop in 1971 was 'Cleaning and Sanitation'.

The issues remain the same, only the nature of the problem changes. In the early 1990s enterohaemorrhagic strains of *E. coli* (EHECs) caused fatal food-poisoning outbreaks in the US, Australia and other countries. The US outbreak led to the publication, in 1994, of proposed FSIS rules to reduce the prevalence of pathogens on meats (Mega Reg). Two of the requirements of the rules were: regular testing of chilled carcases; and, the application of HACCP to meat production. MIS was closely involved with training meatworks staff to test carcases and to develop and implement HACCP plans, ensuring continued access to the US export market.

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Investigations of hot water for decontamination of carcases began in the 1970s. Procedures developed first for smallstock carcases were adapted for beef sides, and development work continued at various establishments. In 1994 the first commercial system was installed at Oakey Abattoir. Commissioning work which involved extensive temperature and microbiological testing of water and beef sides, under the guidance of MIS scientists, continued for almost three years until the unit became fully operational in 1997. This installation has been followed by other hot water and chemical decontamination units. In those plants where decontamination systems are operating, the effectiveness of these systems has been clearly demonstrated.

Vacuum packaging

The first consignment of vacuum-packaged, chilled meat to be shipped overseas left for Japan in 1969. It was a success. The first container load was shipped in 1970 and, in the early years of the export trade in vacuum-packaged chilled meat, problems were frequent: most notably the severe discolouration problems—browning and greening; and the highly undesirable odour problems encountered with green meat of high pH—the odour of hydrogen sulphide (rotten egg gas) in particular. Other problems included: discolourations, e.g. brown spots on fat caused by yeasts, excessive weep and slack packs.

Vacuum-packaging was subsequently extended to lamb primals and carcases, and additional problems were encountered. MIS first distributed information on vacuum-packing sheepmeat in 1973 (MRR 3/73) and several publications have followed over the years since.

New chamber-evacuating equipment and packaging films, and better handling and shipping techniques have led to widespread acceptance of vacuum-packaging of beef and lamb by both domestic and export markets. The research undertaken by CSIRO focused on the microbiology of the meat, and the factors that influence the numbers and composition of bacteria—notably hygiene, film properties and temperature of storage, although gas bubbles in packs and weep, or drip loss (and the factors that exacerbate it), were also studied.

Several projects were directed at setting acceptable storage times for vacuum-packaged beef, lamb, and pork. These initial estimates were based on assessments of the odour emanating from the just-opened packs, and on odour and flavour assessments of the meat once cooked. Storage-life estimates for vacuum-packaged beef, lamb and pork were first tabulated and published by MIS over 20 years ago; and, for at least 15 years, CSIRO scientists worked with meat processors and the suppliers of equipment and vacuum-packaging films, to resolve problems that arose. MIS staff held workshops across Australia and the publications prepared for those seminars are still used as sources of technical information today.

Incidents of discolouration, particularly of lamb, continue to be the subject of regular requests for advice; however, the extensive work by MIS has helped make the quality of Australian chilled meats the envy of other exporting countries.

It is evident that with current industry practices, the benchmarks for acceptable quality and storage life have been set much higher. To meet the revised benchmarks, MIS staff are currently undertaking new studies. With the collaboration of several exporting establishments, vacuum packs of primal cuts are being taken from normal production lots for microbiological and sensory assessment after periods of chilled storage of up to, and beyond, 20 weeks. Validation data for extended storage lives will give the Australian meat industry a strong advantage in export markets.

Figure 2: Colour defects in meat

Specification of manufacturing meat

MIS first became involved in the correct specification of the chemical lean (CL) content in the early 1970s, by recommending sampling procedures to better withdraw representative samples for testing. On-site assistance provided by MIS regional staff proved invaluable for industry-wide adoption of acceptable sampling and testing procedures, and MIS has been at the vanguard of lean meat specification ever since.

Refinements to testing methods have been developed, evaluated and introduced, the most notable being the rapid microwave drying procedure that was first made available to industry in 1983. The procedure is still widely used in Australia and overseas and advice on its optimal application is still sought from MIS on a regular basis.

To make core sampling quicker and easier, MIS developed a coring attachment for electric and pneumatic drills from which the sampled meat could be quickly ejected using air pressure. In those establishments that still focus on removing core samples for testing, the air ejection corer is still widely used.

MIS's first exposure to in-line measurement of lean content was during the 1970s when the EMME boneless-meat analyser was evaluated in plants in Victoria and Queensland. The analyser proved to be unreliable, but a new generation of the instrument, the MQ27, was developed by

Figure 3: In-line CL measuring equipment

CSIRO in cooperation with a US manufacturer. It was evaluated, refined and finally installed in-line at AMH Dinmore in 1990. Many of these units have since been installed and continue to operate.

Benefits realised from using the in-line equipment—timely feedback to boning room staff on their performance, product summaries and consignment reports—were found to be significant, but the overwhelming benefit was financial, through labour savings and packing more closely to CL specification. In 1993, the monetary return to one plant alone (AMH Dinmore) due to the reduction in quantity of lean meat 'given away' was found to be at least $800,000 per year. Returns to the industry as a whole were estimated to be increased by the order of $20 million per year—and complaints regarding noncompliance with CL specifications have been minimised.

Carcase chilling

The importance of control of chilling conditions to inhibit bacterial growth, while avoiding excessive weight loss, was first discussed in 1970 (Newsletter 70/5). Mindful of these requirements and the need to optimise meat colour, research undertaken by MIS and other CSIRO scientists led to recommendations for optimal operation of carcase chillers during the 'pull down' and holding phases. MIS conveyed these recommendations to industry along with strategies to minimise condensation.

A national study of the microbiological quality of Australian meat in 1993 identified that bacterial growth occurred during the weekend chills, bringing the chilling practices at some abattoirs into review. Investigations by MIS scientists ensued and recommendations for chilling practices that could minimise both microbiological growth and fat hardness were discussed at a series of seminars held in 2001 on the topic 'Dealing with refrigeration incidents'.

Industry first sought MIS participation in spray chilling in the mid 1980s. It was discussed at a series of seminars in 1993; and in 1997 and 1998, investigations of the spray-chilling procedure at a NSW export establishment showed that the rate of surface cooling of beef sides in a spray was greater than for sides in a conventional chiller. The spray-chilled sides remained colder over a weekend after which there had been less growth of bacteria than on the sides held in the conventional chiller. The investigations showed that the spray-chilled sides could be held colder without causing excessive hardening of the fatty tissue, meaning they were still acceptable to boners. The investigations were related to industry in 2002, and MIS continues to participate in investigations of spray chilling, the most recent ones being in early 2009.

Hot boning, warm boning

At the request of industry, CSIRO first began considering the feasibility of hot boning of carcases in 1969, the emphasis being on associated microbiological problems. The difficulty of evaluating the different procedures using commercially produced meat led, in 1971, to CSIRO microbiologists establishing a predictive model.

MIS staff undertook validation studies for a considerable number of clients employing both microbiological tests and time-temperature measurements that were compared with times and temperatures specified from the predictive model. MIS and other CSIRO staff worked closely with AQIS, EMIAC and industry committees to refine the process requirements as more extensive information became available from in-plant studies.

Figure 4: Monitoring cooling of hot boned meat

Using the model, a newsletter was distributed giving handling and cooling recommendations for processors of hot boned meat so that bacteria such as *Salmonella* were unable to multiply.

The development, evaluation and validation by the University of Tasmania (UTas) and MLA of sophisticated models for predicting the growth of *E. coli* on meat provided an even more valuable tool for assessing the potential extent of increases in numbers, and the predictive model was used and recommended by MIS from 1998. An AQIS meat notice in 2000 made possible the use of a set of criteria based on an index termed the Hot Boning Index (HBI) which was calculated using the UTas predictive model. The HBI proved to be very useful for assessing both true hot boning and the 'warm boning' or 'boning on the curve' processes that many processors, particularly those operating two shifts daily, have adopted.

MIS also had a significant role in the promulgation, in 2005, of the Export Control (Meat and Meat Products) Orders in the extension of the hot-boning index criteria to overnight and weekend chilling of beef sides.

With the input of MIS and others, AQIS extended the predictive model to cooling all hot products, including carcases, and the criteria are now written into the regulations as the Refrigeration Index (RI).

Offal and co-products

The problem of Salmonella in meat meal was first addressed in a 1971 newsletter. In 1991 the results of an investigation to discover reasons for both sporadic and endemic contamination of meat meal with Salmonella were distributed. The newsletter included a recommendation that HACCP principles should be introduced for meat meal production and a model quality assurance program for the rendering industry was distributed.

The quality of tallow and the factors affecting it was one of the areas of focus on co-products by MIS staff during the 1970s and 80s. Procedures were developed to preserve raw materials for rendering and to measure tallow colour.

A workshop entitled 'Better rendering' was first run in 1978 and similar workshops have been run at regular intervals since, the most recent being in 2008. Investigations by MIS staff that have been reported at the workshops cover quality stabilisation of raw materials and their preparation for rendering, the different rendering processes, tallow washing, chemical analyses as well as the microbiological quality of meat meal mentioned above.

The first studies relating to the yields of offal products and other organs and glands were undertaken by MIS in the 1970s. More comprehensive information on offal products was reported in 1991, and a set of tables was provided that made it possible for processors to better calculate how much offal, tallow and meat meal would be expected from different categories of cattle and sheep.

In 2003 a rendering-yields spreadsheet calculator was prepared and posted on the FSA meatupdate website. More recently—in 2008—MIS prepared and distributed a Meat Technology Update which described a study undertaken by MLA to better understand the factors that influence the recovery of edible offal products. The Update provided yield data (still current) for a range of bovine and ovine offal items.

Refrigerated storage and transport

In 1978, a newsletter that summarised investigations undertaken by CSIRO to define the performance of shipping containers for holding frozen meat, was distributed. Included in the newsletter was a table that provided estimates of times for which frozen meat could safely be held in containers without active refrigeration (as in the case of road transport or loss of container power). Times were provided for frozen meat at temperatures (at door closure or loss of power) ranging from minus 23.3°C to minus 10°C, and for ambient temperature conditions that ranged from 15.6°C to 37.8°C.

MIS used the estimates for many years when called upon to provide advice to AQIS or processors about the implications to food safety and wholesomeness of meat in containers off power for extended periods. In 2006 the highly-instrumented container test facility at the Food Science Australia site at North Ryde was used to obtain large temperature data sets which were used to update the time estimates.

Also during 2006, MIS undertook an investigation where Australian and New Zealand frozen product was monitored throughout the cold chain to discharge in the USA. The investigation led to recommendations of practices for loading cartons into shipping containers or refrigerated cargo holds. Meat Technology Updates and information sheets were released to industry between 2005 and 2007 to provide information on efficient packing and operation of containers and on the implications of certain breaks in the cold chain.

Committees

MIS participates in, and continues to contribute to, many industry and government committees, the most notable being the Export Meat Industry Advisory Committee (and its predecessor committees) and the Meat Standards Committee.

Website

With the wider acceptance of the internet for sourcing information, MIS introduced a dedicated website in 2001 to make the *Meat Technology Update* newsletters and *What's New* summaries available electronically. The site has since been expanded to include a large quantity of technical information held by CSIRO and FSA, and by MLA. It now contains over 1,000 documents and is regularly updated.

The website receives over 2,000 visitors per year, the majority of whom are people directly associated with the red meat industry.

Economic benefits

Perhaps the biggest benefit to industry from MIS activities over the past 40 years, and the most difficult to quantify in financial terms, has been the uptake of improved procedures and quality assurance, leading to improved customer satisfaction through the achievement of:

- world-best microbiological quality of chilled and frozen meat, offal and other co-products;
- optimum visual and eating quality of chilled and frozen meat;
- product that is true to specification, leading to reduced numbers of rejections and complaints; and
- extension of storage life of chilled meat.

Other important benefits have been: improved yields of meat, offal and other co-products; labour and operational cost reductions; and minimisation of environmental concerns.

Forty years on, the MIS continues to serve the meat processing industry with timely advice and essential scientific research to ensure the continued high quality and acceptance of Australian meat products across the globe.

Further information

www.meatupdate.csiro.au

Contact us for additional information

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