MEAT TECHNOLOGY UPDATE
Cutting edge technology for the meat processing industry

Meat technology update

6/07 – December 2007

Producing quality sheep meat

This Update presents recent findings on some slaughter floor influences on sheep meat quality.

New electrical inputs during slaughter and dressing help to deliver better quality sheepmeat. Medium voltage electrical stimulation enhances meat quality by improving tenderness and meat colour. High frequency immobilisation of bodies at slaughter reduces involuntary movement and permits abattoir workers to begin processing sooner. Medium voltage stimulation at low frequency (10 Hz) hastens blood release.

Also discussed is the 'eating quality window' and its application by sheepmeat processors. Results show that without electrical stimulation, the proportion of carcases that fall within the window is about 5%. With optimal stimulation, the proportion rises to 90% based on a revised window of pH 6.0 between 18–35°C.

Electrical technologies

A range of new electrical technologies is helping Australian processors to consistently deliver better quality sheepmeat. Medium voltage electrical stimulation enhances meat quality by improving tenderness and meat colour. In addition, it can also improve occupational health and safety, increase blood collection and enable faster carcase throughput times. The uptake of this new technology in the Australian sheep meat processing industry has been extensive with 14 abattoirs now having some form of the new technology installed, representing the majority of the slaughter capacity in the country.

The benefit of using electrical stimulation is that it reduces tenderness variability and allows meat to reach tenderness levels acceptable to consumers sooner than unstimulated product. This benefits producers, processors and consumers by boosting the perception of lamb in the market place and therefore increasing overall lamb consumption. A variety of electrical inputs are now available for use by Australian meat processors. Extensive research has been undertaken to ensure the units are optimised to best suit abattoirs requirements.

Figure 1. Six-module medium-voltage post-dressing stimulation system. The number of modules (electrodes) is determined by chain speed. With a faster chain, more modules are required to ensure only one carcase is on an electrode at any one time.

Medium voltage stimulation

A new approach to electrical stimulation has been developed by Meat & Livestock Australia based on medium voltage stimulation (MVS). These systems are favoured over the traditional high voltage systems because (1) they use less electricity and are cheaper to run, (2) are safer for workers as they comply with Australian occupational health and safety regulations, (3) can be located at either the start or the end of the chain depending on the availability of space and (4) they can deliver electricity to each carcase individually dependent on the responsiveness of the carcase. They are more effective than low voltage systems.

How it works

The system is devised of segmented electrodes which ensure that only one carcase contacts the electrodes at any one time. The current remains constant and the voltage is varied (peak 300 V) by controlled electronics which determine the resistance of the carcase and this feedback system alters the voltage accordingly.

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Improved meat quality

Medium voltage systems are an effective way of controlling the rate of pH decline of carcases post slaughter. The rate of pH and temperature decline of a carcase can significantly affect meat eating quality. If the pH decline is too slow (high pH at low temperatures), cold shortening may occur. This is extremely detrimental to the quality of the meat and will result in tough meat and darker meat colour.

The Sheep Meat Eating Quality (SMEQ) program identified that for optimal eating quality, meat intended for the domestic market (short aged) should come from a carcase that has a pH of 6 while the carcase temperature is between 18–25°C . Research has been underway aimed at optimising the MVS units to achieve a rate of pH decline that increases the number of carcases that reach a pH 6 between 18–35°C (the eating quality window); this research is referred to again later.

Immobilisation for improved OHS

The use of high frequency immobilisation (Figure 2) at slaughter reduces animal movement and enables abattoir workers to begin processing the carcases safely within approximately 30 seconds of death. These systems have been shown to have no detrimental effect on meat quality.

Figure 2. High frequency immobilisation reduces animal movement and permits early and safe commencement of processing.

Increased efficiency

If medium voltage electrical stimulation is used at the start of the chain (Figure 3), the amount of collectable blood at slaughter can be increased. This application of electrical stimulation has the potential to reduce abattoir waste, reduce water use and provide additional income for those abattoirs that process blood.

The amount of blood released within 2 minutes of slaughter was 62% greater when a thoracic stick and low voltage stimulation (10 Hz) were used in combination with a Halal slaughter compared to Halal slaughter alone. This process can also improve meat quality and increase consumer acceptance by improving meat colour.

Electrical stimulation also has other efficiency benefits as abattoirs can run their chillers at lower temperatures, thus reducing evaporation losses without compromising eating quality.

Figure 3. Medium voltage stimulation after sticking hastens and increases blood release.

pH and temperature decline and the eating quality window

The rate of pH and temperature decline of a carcase can significantly affect sheepmeat eating quality. The muscle pH of a carcase declines post slaughter from 7.2 to about 5.5 due to the conversion of glycogen (muscle energy source) to lactic acid. If the rate of pH decline is too slow (high pH at low carcase temperature), cold shortening may occur.

The ideal 'window' is a specification used to describe the relationship between pH and temperature fall during chilling and the objective is to manipulate pH fall so it passes through the window.

Hitting the window can shorten the ageing time of meat to reach tenderness acceptable to the consumer, reduce the variation in tenderness, and enhance meat colour. This benefits farmers, processors and consumers by boosting the perception of lamb in the market place and increasing overall lamb consumption.

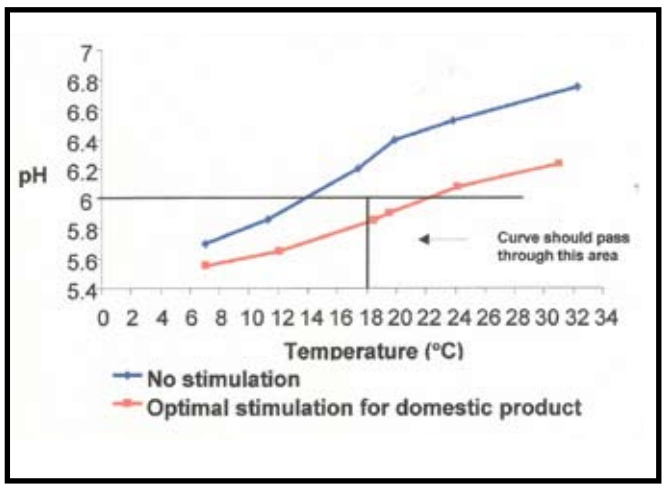

Figure 4. Stimulation results in carcases attaining the pH-temperature window more frequently.

Meat processors participating in the Meat Standards Australia (MSA) Program for Sheep Meat will be required to measure and control systems to 'hit' the pH temperature window. The evidence says that sheep and lamb processors cannot attain the window without methods to either slow temperature decline or speed up pH decline. The former approach can compromise food safety; but the latter option can be achieved with electrical stimulation of the carcase and is the preferred one.

Figure 5. pH and temperature are measured at the lumbar-sacral junction after overlying fat is removed.

Measures of pH-temperature decline

The rate of decline is expressed in terms of the temperature at which the loin muscle of the carcase reaches a pH of 6. To calculate the temperature at pH 6, pH and temperature readings are taken at timed intervals using a combined pH/temperature meter during chilling. Using the standard location for measurement is very important. This is found at the lumbar-sacral junction and overlying fat is cut away so as to prevent fouling of the pH electrode (as shown above). These data are then used to calculate a rate of pH by temperature decline from which it is possible to predict the temperature at pH 6.

Compliance rates

In practice there is considerable variation between carcases and it is difficult to get all carcases within the window under commercial conditions. Results from abattoirs in different locations around Australia show that the number of carcases which can achieve a pH of 6.0 at 18–25°C, without electrical stimulation is about 5% nationally, but this will vary from plant to plant. With the use of an optimal electrical stimulation setting this can be increased to over 60% of carcases depending on the chilling regime of the abattoir (see table below). Recent research has shown that it is possible to expand the temperature range for the window to 18–35°C for lamb that is Achilles-hung and aged for 5 days, without any detrimental effect on eating quality. Expanding the temperature range would mean that for the example in the table below, 90% of carcases would make the window when stimulated, rather than 60%.

Table 1. More carcases fall within the eating quality window if they receive medium voltage stimulation. Test findings at a WA abattoir.

	ph temperature range according to SMEQ 18–25°C guidelines		
	% of carcases @ pH6 between 18–25°C	% pH <6 at 25°C	% pH >6 at 18°C
No stimulation	15	0	85
Optimal setting for domestic market (2.5ms, 1A, 15Hz)	60	30	10

New pH temperature guidelines for sheep meat

Australian research has identified that for optimal eating quality of sheepmeat destined for specific markets, the targets in the table should be met.

Table 2. Temperature range at pH 6 required by MSA

Ageing period	Hanging system	Required temp @ pH6
Short ageing period of 5 days (domestic product)	Achilles hung	18–35°C
Short ageing period of 5 days (domestic product)	Tender stretch/ pelvic hung	8–35°C
Longer ageing period of 10 days	Achilles hung	8–18°C

Auditing performance

Processors should independently audit their plants to determine compliance rates of carcases falling within the pH-temperature window. If a low percentage of carcases hit the window, then a number of alterations can be made including: the use of electrical stimulation, which accelerates the rate of pH decline; varying the stimulation time; and setting or adjusting the chilling regime.

On audit day, processors should randomly select 4 consignments per day that reflect the variation in carcases being processed over the day. Within each consignment 25 carcases should be measured (i.e. 100 sheep per day). The pH and temperature of each carcase should be recorded at 20–30 mins post slaughter (on entry to the chiller) and then again when the temperature at the lumbar-sacral junction is at 18°C. This data should then be used to calculate the temperature at pH 6 using the following equation:

$$\text{Temp at pH6} = \text{Tempi} - \frac{\text{pHi} - 6}{(\text{pHi} - \text{pHs})/(\text{Tempi} - \text{Temps})}$$

Where:
Tempi and pHi represent the first temperature and pH measurement taken 20-30 mins post slaughter (usually above pH 6), and Temps and pHs represent the measurement taken when the meat is at around 18°C (usually below pH 6).

This process should be completed a minimum of 4 times per year, and be done over a variety of seasons. To test whether the stimulator is working, 5 carcases from 4 lots can be measured on entry to the chiller. This should be done monthly.

Contacts

For queries on electrical technologies Dr David Hopkins (NSW DPI), Ph 02 6349 9722.

Further Reading

Hopkins, D.L., Shaw, F.D., Baud, S. and Walker, P.J. (2006) Electrical currents applied to lamb carcases – effects on blood release and meat quality. Australian Journal of Experimental Agriculture 46: 885-889.

Pearce, K.L., Hopkins, D.L., Toohey, E.S., Pethick, D.W. and I. Richards (2006) Quantifying the rate of pH and temperature decline in lamb carcasses using mid voltage electrical stimulation in an Australian abattoir. Australian Journal of Experimental Agriculture 46: 869-874.

Toohey, E.S., Hopkins, D.L., McLeod, B.M. and Nielsen, S.G. (2006) Quantifying the rate of pH and temperature decline in lamb carcases at three NSW abattoirs. Australian Journal of Experimental Agriculture 46: 875-878.

Toohey E.S. and Hopkins, D.L. (2006) Optimisation of a new generation pre-dressing mid-voltage electrical stimulation unit. Proceedings 52nd International Congress of Meat Science and Technology, Dublin, Ireland, p. 627-628.

Toohey, E.S. and Hopkins, D.L. (2007) Does high frequency immobilisation of sheep post-death affect meat quality? Proceedings of the 67th New Zealand Society of Animal Production. p. 420-425.

Key Messages

- **A number of electrical inputs are available to Australian meat processors to improve meat quality and occupational health and safety.**
- **Medium voltage electrical stimulation units at the start or the end of the chain can improve tenderness and meat colour by increasing the rate of pH decline.**
- **High frequency immobilisation at the start of the chain reduces animal movement and improves occupational health and safety.**
- **Medium voltage electrical stimulation at the start of the chain can increase the amount of collectable blood that can be sold, and also reduce waste.**
- **Optimising the rate of pH and temperature decline improves sheepmeat eating quality.**
- **Meat Standards Australia will require sheepmeat processors to measure and control systems to fall within the pH temperature window.**
- **Four times per year, processors should select 4 consignments per day and 25 carcases per consignment to determine the number of carcases hitting the window. pH should be recorded 20–30 mins post slaughter and again when the carcase is close to 18°C.**

The information contained herein is an outline

Contact us for additional information

Meat Industry Services is supported by the Australian Meat Processor Corporation (AMPC) and Meat & Livestock Australia (MLA).

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