

# tips & tools



MSAS5

MEAT STANDARDS AUSTRALIA

## The effect of pH on sheepmeat eating quality

### The effect of pH on eating quality

Every animal has a certain amount of energy contained in its muscles in the form of glycogen. Once the animal is dead, the muscle glycogen is converted to lactic acid that causes the pH to fall. If there is not enough glycogen available in the animal, insufficient lactic acid will be produced and the pH will remain high, resulting in dark cutting. The main point to consider is that adequate glycogen levels need to be maintained to deliver the ultimate pH required for eating quality.

If the concentration of glycogen falls below a threshold concentration (around 0.8g/100g) because of poor nutrition or other factors such as poor handling and stress, the pH of the resulting meat becomes higher than normal (figure 1) and will result in high pH and dark cutting.

No matter how well lambs and sheep are prepared by the producer, poor practice in the days and hours leading up to slaughter can cause dark cutting. Dark cutting meat is characterised by a darker colour, coarse texture, reduced tenderness and a stronger flavour in sheep. At the retail level, consumers are likely to reject this meat on the basis of appearance. Dark cutting meat results from stress in the live animal; the outcome is sheepmeat with a pH higher than the normal 5.6. At higher pH bacteria grow more rapidly and will have a shorter shelf life.

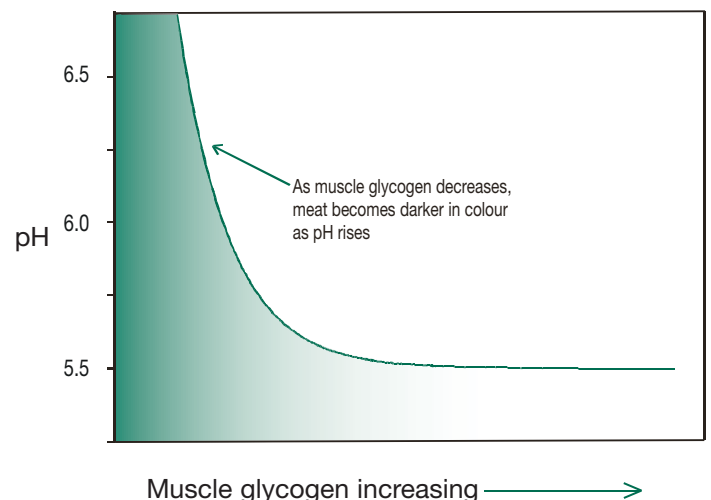
### pH decline

The temperature at which a carcass enters rigor (pH 6) can significantly affect meat quality. If the carcass temperature falls too quickly before the carcass enters rigor (pH 6), then cold shortening may result, often leading to toughness.

### Key points

- Glycogen levels prior to slaughter will determine the ultimate pH.
- Electrical stimulation can be used to ensure carcasses enter rigor (pH6) at the desired temperature.
- Tenderstretch carcasses hung by the pelvis have a wider temperature window and can enter rigor between 8°C and 30°C, in combination with five days ageing.
- Aggressive chilling regimes (ie high air speed, low temperature) can increase toughness.

Figure 1: Muscle glycogen and pH of resulting meat



## Electrical stimulation

Electrical stimulation provides a method for accelerating the fall of pH. When properly applied, electrical stimulation will ensure muscles enter rigor (pH 6) at a temperature that will avoid cold shortening and hence maximise eating quality. It will guarantee better consistency in all sheepmeat categories.

## Key principles of electrical stimulation

- Electrical stimulation is a useful tool for processors to control rigor onset. For continuous effectiveness, it is critically important that stimulator systems are monitored and that treated product is temperature-pH measured.
- Electrical stimulation is not necessary if meat is chill-aged for at least 10 days before consumption and a temperature window of 8–18°C at rigor is achieved.
- The optimum period for electrical stimulation can be determined by regularly checking carcasses with a calibrated pH probe and a temperature meter.
- There are no adverse eating quality effects from correctly applied electrical stimulation. However, if incorrect electrical stimulation results in carcass rigor above 25°C, then drip loss and meat colour stability problems may occur.
- Electrical stimulation of sheepmeat does not increase or decrease contamination of carcasses by micro-organisms. Electrical stimulation can in fact improve shelf life by enabling more rapid chilling.
- Measurements are made at various times after slaughter and results are assessed to determine the temperature at which the eye of loin pH reaches 6.0 and the pH at which rigor develops.

The electrical current stimulates the conversion of glycogen to lactic acid so that muscle pH drops rapidly during current application (figure 2). Electrical stimulation of carcasses causes an early and rapid fall in pH so that muscles enter rigor (pH 6) sooner and at a higher temperature.

Figure 2: The effect of electrical stimulation on pH

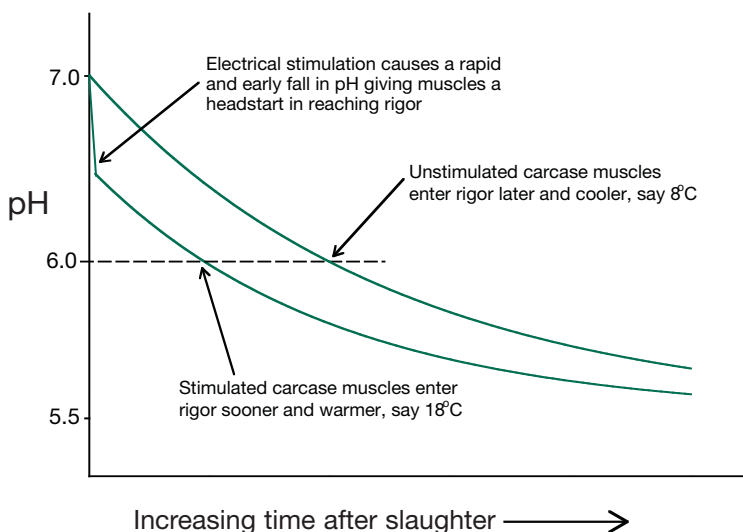
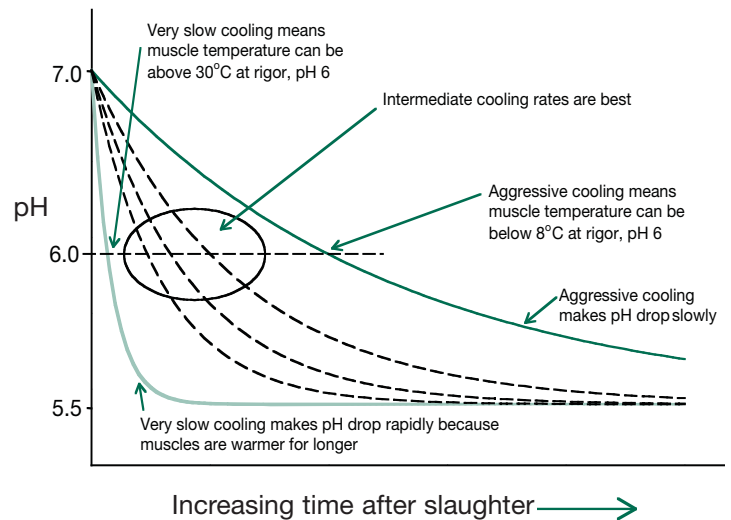


Figure 3: Impact of carcass cooling on pH



## Carcasses cooled too quickly

If carcasses are cooled too quickly, temperature decline exceeds the pH decline and follows the upper line shown in figure 3. If rigor onset occurs below 8°C, the muscles tend to cold shorten and ageing is slowed. In addition, the display colour of meat will often be darker than usual.

In extreme cases, fast cooling leads to permanent toughening and, at the very least, it causes slow ageing. The ideal balance is to cool carcasses between the two extremes; this is illustrated by the three dashed curves in figure 3. However some processors, when considering specific markets, may choose to operate to the lower or upper curve.

## Carcasses cooled too slowly

If carcasses are cooled too slowly (eg because of inadequate chilling capacity), muscle pH falls rapidly (see the lowest line in figure 3) because the chemical reactions in the muscle will have been accelerated.

If the temperature of the muscles is above 30°C at the onset of rigor (pH 6), the muscles will be inclined to heat shorten. Other quality problems occur under these conditions, such as excessive drip, and the meat can appear paler than normal when displayed.

Figure 4 shows that electrical stimulation maximises the frequency of satisfactory eating experiences particularly when products are eaten soon (two days) after slaughter. However, further ageing in all treatments will continue to improve eating quality.

Under any treatment, the importance of sufficient ageing time for the development of optimum eating quality cannot be overemphasised.

Figure 4: Effect of electrical stimulation on overall eating experience

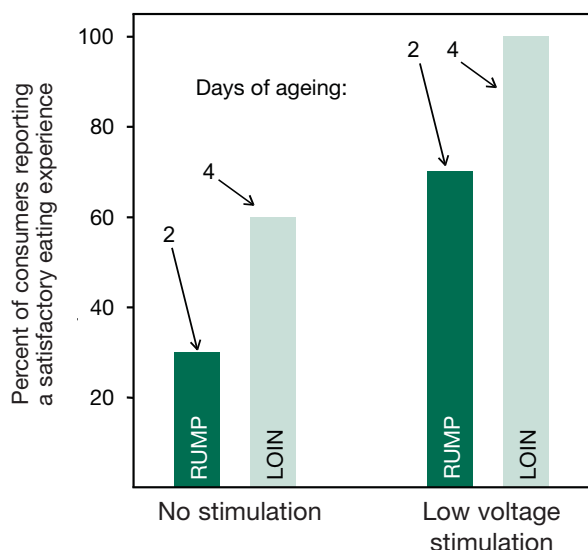


Table 1: Processing and ageing conditions for optimum eating quality in different markets

Target market	Domestic chilled trade		Domestic or export chilled trade	Frozen
	Tenderstretch	Achilles		
<i>Hanging method</i>	Tenderstretch	Achilles	Achilles	Achilles
<i>Electrical stimulation needed</i>	No	Yes	No	Yes
<i>Enter rigor (pH 6) at:</i>	8–35°C	18–25°C **	8–18°C	18–25°C
<i>Minimum ageing period</i>	5 days*	5 days*	10 days	5 days before freezing
<i>Storage temperature</i>	1°C	1°C	-1°C	1°C then -18°C

\* This is the optimum time to maximise sheepmeat eating quality. For most domestic/short markets, this is not feasible. Optimum quality will take five days.

\*\* Provisional results. Lower limit may be reached.

## Types of stimulation

When purchasing or upgrading electrical stimulation equipment, consideration should be given to the newer types of lower cost, low voltage/high frequency systems. These are as effective as high voltage systems. Medium voltage systems can be installed to operate during the bleeding process or, alternatively, post evisceration.

Researchers consider the time and processes between stunning and chilling to be the most crucial element in eating quality. Sheepmeat eating quality can be maximised for individual situations by using a combination of processing tools as follows:

- electrical stimulation;
- hanging method;
- temperature at which the carcass enters rigor (pH 6);
- minimum ageing period; and
- storage temperature.

Table 1 summarises the processing and ageing recommendations for optimum eating quality relevant to specific markets.

There are specific processing regimes known to optimise the consistency and eating quality of all classes of sheepmeat for any market.

## Optimum conditions for pre-slaughter pH management

Glycogen levels prior to slaughter will determine ultimate pH. The following points list optimum conditions for reducing animal stress therefore maintaining glycogen levels prior to slaughter.

### 1. Livestock receipt

- Unloading areas are easily accessible to transport operators.
- Trucks move immediately to unloading area and are unloaded without delay.
- Trucks arrive in good condition, with non-slip flooring and at recommended loading densities.
- Trained stockmen are used to unload animals.
- Use of electric goads and dogs are minimised. Flappers or other goads used.
- Sheep are moved directly to lairage pens.
- ‘Downer’ or injured sheep are assisted to their feet prior to unloading and treated accordingly.
- There are no obstructions in the unloading operation.
- Familiar sheep are left in their groups, and not mixed as they arrive.
- Ramp facilities are of a correct design.

## 2. Lairage facilities and livestock

- Animals are inspected by trained handlers upon arrival. Injured sheep are separated and treated accordingly.
- Sheep are placed in the same lairage pen which will house them for the entire period before killing.
- Trained stockmen are used to move or redraft animals.
- Canvas or leather flappers, soft polythene pipes or rattlers are used in preference to electric prodders.
- Pens are situated well away from unloading area to minimise disturbance to resting sheep.
- Animals are maintained in their consignment group.
- Lairage pens are well drained, sheltered and/or shaded.
- Sheep are given adequate time to rest in lairage prior to slaughter.
- Clean fresh water is available in the pens.

## 3. Assembling for slaughter and pre-slaughter practices

- Sheep move easily into laneways without disturbing other pens of sheep.
- Laneways are wide enough to avoid pushing and interaction between sheep.
- There are no sharp corners, obstructions or distractions in laneways and races.
- Trained stockmen are used to draft and move sheep through laneways, races and ramps.
- Non-slip flooring is used.
- Grooved stair steps are used on concrete ramps.
- A level surface is provided at the top of the ramp prior to the stunning box entry.
- There are no sheep on ramps during breaks and stoppages.
- Electric prodders are only used on animals which are baulking and have a clear path ahead.

## 4. Stunning

- Fully trained personnel with sheep handling skills are used for stunning
- The entrance to the knocking box is inviting to sheep. Goads are used appropriately for entry into the box.
- The knocking box is solid underfoot and quiet in operation.
- The knocking box uses a well designed head restraint.
- The stunning device provides an effective stun and is

easily positioned.

- There are no distractions to the sheep in the knocking box.
- Stunning is not delayed, nor sheep held in the box during stoppages or breaks.

## 5. Monitoring of individual lots through lairage

Individual lots are assessed in the following areas to ensure best practice for optimal eating quality outcomes:

- Consignment number and number and type of sheep
- Source (place, private/saleyard)
- Time and date of arrival
- Unloading process (difficulties, downers, delays and dogs or other goads)
- Time to be allocated to resting pen, and pen number
- Ease of movement to pen (drafting required, goads used)
- Conditions in pen (conducive to settling, boggy, other stock mixed in same pen, access to watering points)
- Date and time of assembling for slaughter (taken from pen)
- Ease of movement along laneways (drafting required, goads used)
- Washing of sheep (restlessness during washing, time in wash yard)
- Movement up ramp to slaughter floor (time on ramp, goads used)
- Movement into knocking box (ease)
- Time of stunning
- Stun to stick time
- PH temperature declines performed as routine monitoring.

## For more information

[www.msagrading.com](http://www.msagrading.com) or 1800 111 672



Level 1, 165 Walker Street  
North Sydney NSW 2060  
Ph: +61 2 9463 9333  
Fax: +61 2 9463 9393  
[www.mla.com.au](http://www.mla.com.au)

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