Sheep CRC Practical Wisdom
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SHEEP CRC

QUALITY SHEEPMEAT—MEAT COLOUR AND SHELF-LIFE

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Consumers' decisions to buy meat are strongly influenced by their perception of colour.
The stability of meat colour is affected by a number of on-farm, processing and retail display practices.
Changing some of these practices along the supply chain can therefore improve colour stability, and hence shelf-life, with potentially significant cost savings at the retail level.

Introduction

When meat is sliced, it absorbs oxygen from the atmosphere and the cut surface. Within one hour this process is complete and the surface of the meat is usually bright red; at this stage it is known as the "bloom colour". However as time progresses, the surface of sliced meat will change from red to brown due to oxidation of the pigment oxymyoglobin to metmyoglobin. As meat becomes brown in colour, as shown in Figure 1 below, it is unattractive to consumers.

Figure1. A lamb leg chop showing the change in colour with time from red to brown as the pigment in the meat surface changes from oxymyoglobin to metmyoglobin

The time it takes for meat to deteriorate in colour sets the acceptable time limit for retail display of meat. Currently two days is used as the standard shelf-time for meat packed on polystyrene trays with a polyvinyl over-wrap.

How does colour influence purchase decisions?

Consumers' decisions to buy meat are strongly influenced by meat colour. In a recent consumer survey, 41% of customers said they would not eat meat that appeared brown, even when the use by date had not been exceeded. As a consequence retailers often discount meat to prevent the display period extending beyond 2 days.

How is colour measured?

For research purposes the change in colour during shelf display is measured by a change in light reflectance at specific wavelengths (630nm and 580nm). These measurements are used to calculate the oxymyoglobin/metmyoglobin (oxy/met) ratio and this ratio varies between 7 for very red meat to 1 for very brown meat. The longer the meat is displayed on a retail shelf the lower the oxy/met ratio becomes.

Consumers have identified that when the oxy/met ratio drops below 3.5, the meat is unacceptable. Figure 2 below shows how the colour of the meat deteriorates very quickly once this critical level of 3.5 is reached.

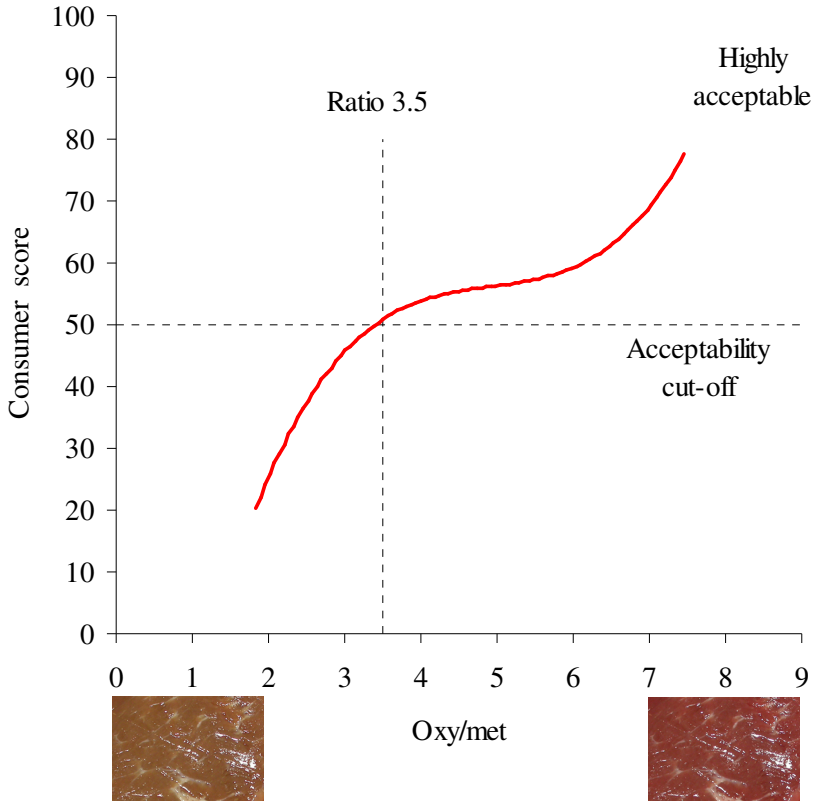

Figure 2. The relationship between oxy/met and consumer perception of meat colour acceptability using a Hunterlab Miniscan reflectometer (using a 25 mm aperture). The oxy/met ratio accounts for about 40% of the variation in the consumer colour scores)

What affects meat colour stability?

Colour stability can be influenced by a number of management factors along the meat supply chain from farm, to meat processing and retail display. A supply chain approach achieves the best result for colour stability.

Table 1: Colour stability of different muscles and their commercial cuts

Colour stability classification	Muscle	Commercial Cut
Stable	m. semitendinosus	Eye round
	m. biceps femoris	Silverside
Intermediate	m. quadriceps femoris	Knuckle
	m. longissimus thoracis et lumborum	Loin
	m. triceps brachii	Shoulder
Unstable	m. semimembranosus	Topside
	m. gluteus medius	Rump

	m. psoas major	Fillet

1. Muscle type

The shelf-life of meat is influenced by the intrinsic biochemical nature of different muscle types. This is important because different cuts contain different muscle types. Some cuts, such as the silverside, do not change in colour within a two-day display time. Other cuts such as topside and rump change colour dramatically within two days of slicing (oxy/met will change by greater than 25%). In between these extremes are cuts such as loin, which are intermediate in colour stability. Table 1 below shows the muscle type and their relative stability in colour.

However under some circumstances, such as ageing for more than 3 weeks before slicing, cuts that are stable may become unstable in colour. Therefore some care is needed in using this broad classification to compare the colour stability of different cuts. In general terms, if a commercial cut is very red, the colour will be less stable and the more responsive the cut will be to management interventions designed to improve colour stability.

2. Lamb production factors

Vitamin E

Vitamin E supplementation can increase the brightness of meat bloom colour as well as the stability of the red colour during shelf display. Vitamin E is a powerful antioxidant whose natural concentration in pastures and crop stubbles decreases seasonally during the dry period. The appearance of brown on the meat surface is an oxidative process; therefore vitamin E concentration in the muscle has an influence on meat colour.

Typically, lambs become deficient in vitamin E during the summer and autumn period in southern Australia (or when there is limited green feed in other areas). Meat derived from lambs that are deficient in vitamin E at the time of slaughter will have poor shelf-life based on colour. This seasonal effect can be avoided by increasing the amount of vitamin E added to finishing diets. For lambs that have not grazed green feed for longer than six weeks, a higher than normal feeding rate (than recommended for animal health and production) is recommended, being 250ppm 2–4 weeks prior to slaughter. However a nutritionist should be consulted and the cost considered before doing this.

Lamb age

Over the length of the annual lamb production cycle lamb age increases as production changes from "suckers" that are 4–6 months of age to "carry-overs" that are 8–12 months of age. As lamb age increases a subtle change in meat colour occurs. Meat from "carry-over" lambs tends to be darker, more intense, less stable and more variable in colour than meat from "sucker" lambs. These changes result from muscle pigment (myoglobin) increasing with lamb age, but may also be due to changes in feed type as the seasons change.

Lamb genotype

Selection for growth rate and muscling has the potential to change the colour of lamb meat. Lambs selected for muscling may have lighter coloured meat, which is more acceptable, and this is the subject of further research in the second phase of the Sheep CRC. Leg cuts from Merino lambs may be darker, less red in colour and less stable in colour during retail shelf display than those from crossbred lambs of the same age. However, this difference has not been seen with Merino loins.

3. Meat processing factors

Electrical stimulation

The effect of electrical stimulation depends to some extent on the type of system used, but a general effect of electrical stimulation is to make the bloom colour lighter and more attractive to consumers. New generation medium voltage systems generally have no effect on colour stability whilst high voltage

systems may cause a small reduction in colour stability. However, these effects depend to some extent on the muscle type and other production and processing factors.

Primal packaging systems
Packaging meat as primal cuts in carbon dioxide causes meat to be redder in hue and more stable in colour compared to meat kept in carcase form exposed to air. Packaging in carbon dioxide can also reduce the likelihood of electrical stimulation having a negative effect on colour stability.

Ageing period
Ageing meat to improve tenderness can reduce colour stability. This effect is seen for meat aged longer than 10 days and the maximum time suggested for ageing without substantial detrimental effects on colour stability is 20 days. If meat is to be aged for extended periods of time, carbon dioxide gas packaging should be considered and the vitamin E status of the lambs should be known. Cuts that are normally stable in colour, such as the silverside, become very unstable in colour when aged for longer than three weeks prior to slicing for retail display. Figure 3 illustrates the effects of ageing and vitamin E supplementation on shelf-life.

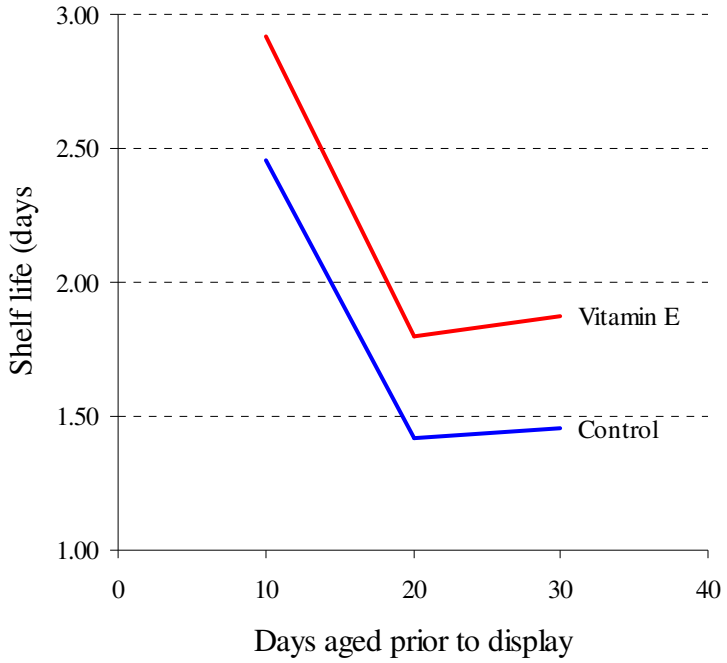

Figure 3. The improvement in shelf-life of lamb meat supplemented with vitamin E

Chilling rate and hot boning
Rapid chilling can improve the colour stability of meat. Hot boning can cause meat to appear darker in colour compared to cold-boned meat.

Freezing
Meat that has been frozen tends to be less stable in colour than fresh meat.

4. Retail factors

Packaging
Modified atmosphere packaging (MAP) can improve colour stability. These systems involve packaging in an oxygen impermeable package that contains a carbon dioxide, nitrogen and oxygen gas mixture. Control of this gas mixture can influence the rate of oxidation of myoglobin. A study in Victoria has shown that MAP doubled the acceptable shelf-life of lamb meat.

Temperature
The rate of oxidation (browning) increases as the temperature of the display cabinet increases. Display cabinets should be kept as low possible. Temperature fluctuations will also promote oxidation.

Lighting
Light can speed the oxidation process so the more intense cabinet lighting is, the faster the meat will discolour.

Take home messages

Colour stability, and hence shelf-life, can be improved by:
- Ensuring vitamin E nutrition of lambs pre-slaughter is adequate
- Use of medium voltage stimulation systems
- Packaging in carbon dioxide
- Ageing of meat for no longer than 10 days
- Ensuring vitamin E nutrition is adequate if ageing is longer than 20 days,
- Use of rapid chilling
- Use of modified atmosphere packaging
- Low temperature and low intensity lighting in display cabinets.

Meat that is of higher risk of colour instability comes from:
- Cuts including the topside, rump and fillet
- Older lambs
- Merino lambs

Further information

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