MEAT TECHNOLOGY UPDATE
Cutting edge technology for the meat processing industry

Meat technology update

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Dry ageing of beef

- **Dry ageing can fill a niche market.**
- **Well-controlled conditions are required.**
- **Only premium products should be selected for dry ageing to justify the higher price required.**

Ageing is a long-established method for improving the tenderness, flavour and overall acceptance of beef. This was traditionally done by 'hanging' the carcase, quarter or primal cut of meat in a cool room or a cool place until it was ready to be sold or consumed. With the advent of vacuum packaging, selected primal cuts could be aged under more controlled conditions, with improvements in yield and the capability of longer storage times. Ageing in a vacuum bag is sometimes referred to as 'wet' ageing. Dry ageing is the ageing of primal cuts unpackaged, in air.

There appears to be increased interest in Australia in dry ageing, especially for the high quality restaurant market where premium cuts from grain-fed cattle of the Angus and Wagyu breeds are often used. Most of the research on dry ageing has been conducted in the United States, and this Meat Technology Update discusses the results of some of this research and provides recommendations on ageing conditions that should be employed to achieve a successful outcome.

Dry Ageing

Facility

Purpose built:

- to hygienic standards
- with air lock or opening to refrigerated area
- cleanable racking
- possibly UV lighting

Conditions

Air temperature:	stable at minus 0.5 to 1.0°C
Relative humidity:	75 to 85%
Air velocity:	low and even (0.2 to 0.5 m/s)

Product

High quality loin cuts:

- pH of 5.4 to 5.7
- not cold or heat shortened

Ageing conditions

The rate of tenderness improvement during ageing is related to temperature: the higher the temperature, the more rapid the changes. However, higher temperatures also promote more rapid bacterial growth, so ageing is usually done at a temperature as low as possible without freezing the meat. Meat commences to freeze at –1.5°C, therefore the ideal temperature for long-term ageing is –0.5°C ± 1°C. If the product is to be aged for only 1 to 2 weeks, higher temperatures of 2 to 3°C could be acceptable. Temperature stability is important; therefore, the dry-ageing room should have an anteroom—or open to another refrigerated area—to prevent ingress of warm, moist outside air. The provision of a plastic-strip door will reduce entry of outside air when the door is open.

The relative humidity (RH) of the air plays an important role in dry ageing. A low RH will restrict bacterial growth, but promote greater evaporative weight loss and surface drying—which increases trimming losses. An RH as low as 50% has been used in some ageing rooms, but an RH in the range 75 to 85% is generally satisfactory. Other antibacterial strategies such as ultraviolet (UV) lighting and air filtration systems, have also been employed. The normal fluorescent lighting in the room should be switched off when not required.

An alternative to placing UV lights in the room is to circulate the air through a UV-lit chamber so that all the air is treated every 30 minutes. There should be sufficient air flow to provide circulation without dead spots or sites of high velocity. A velocity over the product of 0.2 to 0.5 m/s should be sufficient. Therefore, a dry-ageing room should be a specialised facility using a refrigeration system designed by a knowledgeable refrigeration engineer. The RH and temperature stability of a normal multi-purpose holding chiller is not likely to be suitable for dry ageing.

The ageing room should be equipped with racking with stainless steel mesh shelves that can be easily removed for cleaning. The primal cuts to be dry aged should be placed fat side down on the shelves, so that air can circulate around all sides of each cut (see figure 1 on page 2). In the case of bone-in cuts such as short loins, the cut should rest on the chine bone. Trees or hooks may also be used, but the product must be suspended such that the air can circulate over all surfaces.

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Figure 1: Primal cuts dry ageing on a rack

Eating quality

Flavour

There has been a great deal of discussion as to whether dry-aged beef has a better flavour than beef aged in vacuum packs (wet aged). The main reason for dry ageing beef is to produce a premium product that has a distinctive flavour that is imparted by the process. Some studies have found little difference in consumer preference between the two, whereas others have found a greater acceptability for the dry-aged product. Laster *et al.* (2008) found an increased overall liking for dry-aged rib-eye steaks as the ageing period increased; whereas, there was little change with the wet-aged product (Figure 2). The differences, however, were quite small. Some believe that a dry-ageing period of at least 40 days is required to achieve full flavour development.

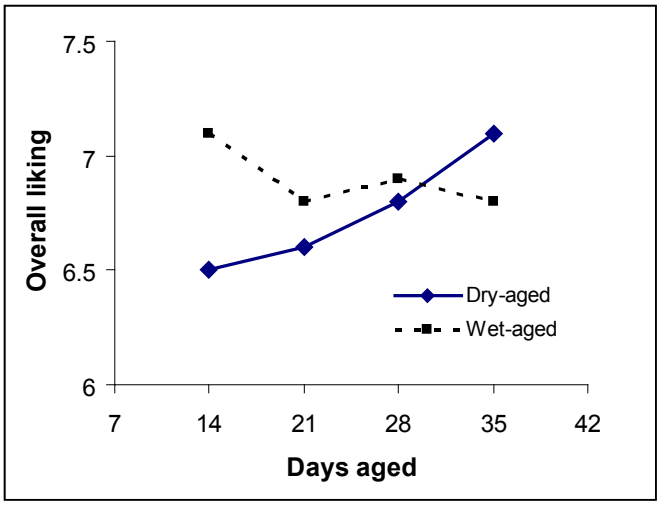

Figure 2: Effect of ageing period on overall liking of dry- and wet-aged steaks aged at -0.6°C, 78% RH (10 = like extremely; 1 = dislike extremely) (Adapted from Laster et al., 2008)

When comparing dry and wet ageing, panellists have given dry-aged steaks higher scores for beefy and roasted flavours, and lower scores for serumy, sour and metallic flavour intensity. Therefore, dry ageing resulted in the development of more positive flavour intensities; and vacuum ageing had the potential for negative flavours (metallic, sour). When consumers have shown no preference for the dry-aged flavour, it is believed that it may be partly due to them being more familiar with the flavour of wet-aged beef. Those who recognised, or preferred, the dry-aged flavours were willing to pay more for that product.

Analytical analysis of the volatile compounds from wet- and dry-aged beef showed that the dry-aged product had significantly more heptane—which can be produced by the auto-oxidation of oleate, a major fatty acid in beef muscle. The exposure to air during ageing presumably contributed to this. Dry-aged beef also had significantly higher percentages of esters and other miscellaneous compounds, but wet-aged samples had greater percentages of acids; however, it is unclear how these compounds interact to produce positive or negative flavour notes for the consumer.

The role of the ageing conditions (temperature and RH) on the development of the dry-aged flavour do not appear to have been studied; however, it is likely that changes would occur more slowly at lower temperatures. Low temperatures of 0°C or below and RH below 80% should be employed when product is to be aged for periods of 3 weeks or longer.

Tenderness

The tenderness of meat can be improved by ageing, which involves the breakdown of the muscle structural proteins by muscle enzymes termed 'calpains'. Although dry ageing does not result in any greater improvement in meat tenderness than wet ageing, the processor needs to be aware of the ageing time required for development of optimum tenderness, and the pre- and post-slaughter conditions that influence ageing.

The rate of ageing is temperature dependent. A period of about 4 weeks at –0.5°C would be required to achieve the same level of tenderness as 2 weeks at +5°C. Whichever temperature is selected, the rate of improvement in tenderness is highest during the early stages of ageing, and decreases with time.

The ultimate pH of the meat can affect the degree of improvement in tenderness during ageing. Meat of intermediate pH (5.8 – 6.1) is tougher than meat with a normal pH (5.4 – 5.7), and this toughness is maintained for much of the ageing period. Therefore, product selected for dry ageing should come from carcases with an ultimate pH of 5.4 to 5.7, which will have a colour score of 1B to 3.

Muscles that have been cold shortened or heat shortened do not age as effectively as normally chilled meat. Cold shortening can occur if the temperature falls below 15°C while the pH is above 6.0; and heat shortening when the pH is below 6.0 and the temperature is still above 35°C. The heavy, grain-fed carcases from which cuts would be selected for dry ageing are unlikely to cold shorten under normal processing conditions, but heat shortening can be an issue. Excessive electrical inputs to the carcase during dressing can result in a rapid fall in pH leading to heat shortening. The greatest tenderness of meat can be achieved when the muscle enters rigor mortis at close to 15°C. 'Tenderstretching' is an effective method to prevent shortening in most of the valuable muscles of the carcase that are likely to be dry aged, and also enhances the tenderness from ageing.

The tenderness of some muscles improves more during ageing than that of others. As ageing does not affect the connective tissue, those muscles with a high connective tissue content will not improve as much during ageing.

Juiciness

Studies have found that there is an improvement in juiciness during dry ageing. Steaks were significantly juicier after 21 days ageing than after 14 days, which in turn gave steaks which were juicier than those aged for zero or 7 days. This was attributed to a possible loss in water-holding capacity, resulting in more juices being released during chewing; or that the fat was concentrated by the loss of moisture during ageing. Other studies have found no improvement in juiciness over the ageing period and no difference between wet- and dry-aged steaks. Cooking losses for dry-aged steaks tend to be lower than for wet-aged.

Microbiological quality

The growth of spoilage bacteria on dry-aged product is controlled by the low surface-water activity. Therefore, the holding conditions are important to prevent losses due to spoilage. The microbiological quality of dry-aged product should be equivalent to that of vacuum-bag aged meat, provided normal hygiene procedures are followed. The mix of bacteria will be different though, with higher numbers of lactic acid bacteria on wet-aged beef (Ahnstrom *et al.* 2006). The growth of lactic acid bacteria contributes to the storage life of vacuum-packaged meat; whereas, dry ageing relies on reduction of water activity on the surface to minimise bacterial growth.

Packaging

For convenience of distribution and storage, the effects of vacuum packaging before and after dry ageing have been evaluated. Campbell *et al.* (2001) and DeGeer *et al.* (2009) found that vacuum storage before and after dry ageing had minimal effect on the dry-aged flavour.

In the US a water vapour-permeable bag has been trialled for dry ageing. Dry ageing in the bag for up to 28 days improved yields and still allowed development of an equivalent dry-aged flavour, and didn't increase microbiological growth. The bag provided another level of control of the ageing environment possibly allowing less stringent control of the air.

Yield

Evaporation from the meat surface during dry ageing contributes to the distinctive flavour of the product by concentrating the compounds responsible. Therefore, dry ageing results in a much lower yield of saleable meat than wet ageing. There are some weep losses during storage of vacuum-packed meat, but these are minor compared with the dry-aged losses from evaporation and the need to trim the dried and discoloured surface tissue referred to as 'crust'. Smith *et al.* (2008) measured evaporative losses on beef short loins of 5.4 to 8.5% for storage periods up to 35 days at 1.0°C and 83% RH. The amount of saleable meat after dry ageing was considerably less than after wet ageing (Table 1).

Table 1: Saleable meat yield (%) after wet and dry ageing (Smith et al. 2008)

	14 days	21 days	28 days	35 days
Dry-aged	76.5	72.1	71.6	69.8
Wet-aged	87.7	85.3	86.6	87.1

They also found that a greater amount of time was required to prepare the dry-aged product for sale. This was mainly related to the time required for removal of the 'crust' prior to slicing, and some additional trimming to remove dried tissue from individual steaks that had not been removed earlier. Figure 3 (page 4) shows the amount of trim from a dry-aged primal.

As a result they calculated that retail prices of dry-aged steaks from short loins would need to be up to 19% higher to return the same net sales value and margin as obtained from wet-aged short loins.

In addition, dry ageing requires much more chiller space than wet ageing where the cuts can be compactly packed into cartons.

Conclusions

Ageing in a vacuum bag is going to continue to be the dominant method employed in the meat industry due to the control and convenience provided. Dry ageing is much more costly due to the increased trim, space and special environment required, but there is a niche market of discerning consumers who are willing to pay for this premium product.

Figure 3: Trim for a dry-aged primal

Companies interested in producing a dry-aged product need to ensure that they are able to provide the required environmental conditions. They will need to test these parameters to ensure that they can produce a quality product on a regular basis. Importantly, due to the discerning market, only the highest quality product should be selected for dry ageing.

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