



TARGET PORK QUALITY



Carcase chilling systems and their impact on meat quality

Introduction

The chilling system employed has a significant impact on several key aspects of pork, such as microbiology, meat safety, eating quality and even production yield.

The optimisation of a carcass chilling system depends on the market being supplied. If eating quality is of prime importance, then special attention should be paid to issues such as cold shortening. If cost is of prime importance then the priorities are minimising weight loss and maximising throughput. The chilling system therefore should be designed to meet individual needs, in order to satisfy customer expectations.

Current chilling systems in England

The majority of abattoirs in England produce pork on a 24-hour cycle. Such a long batch chilling operation has a number of disadvantages:

- The need for large chill rooms - any increase in production requires a corresponding increase in chill room capacity
- New chill rooms are expensive and existing abattoirs may lack the required space to extend chill capacity
- Chill rooms are often overloaded and this accentuates a very common problem: a high heat load known as the heat peak

The heat peak is due to the large quantity of heat released in the initial hours of chilling which leads to increased weight loss because of the extended cooling cycle. The average weight loss of pork carcasses over a 24-hour cycle ranges from 1.9 to 2.8%. Any reduction in weight loss will have a significant effect on the profits of the pork processors.

Several chilling systems have been developed to overcome the problem of excessive weight loss and ultra-rapid chilling has become the most common alternative to traditional batch chilling in England.

The advantages and disadvantages of these two systems, from an eating quality and a production efficiency point of view, are briefly discussed below.



Characteristics of the common chilling systems in England

(i) Batch chilling system

This is the most common chilling regime applied in England.

- In batch chilling carcasses are loaded into a chiller throughout slaughter and all carcasses in a chill room are cooled together overnight
- Chilling requires a period of 14-16 hours
- The efficiency of chilling is defined mainly by the air temperature and velocity in the chill room, the carcass weight range and the loading pattern for the chiller
- As a guide, pig carcasses under 110 kg should be chilled to temperatures below 7°C within a 24-hour processing cycle with an air temperature close to 0°C at a velocity of 3.0 m/s or more. Less powerful chilling equipment obviously cannot achieve these targets
- Conventional chilling avoids cold shortening and therefore results in enhanced pork eating quality (tenderness) in comparison with faster chilling regimes
- Water-holding capacity for processing is generally good
- There are a number of problems with batch chilling related to operational efficiency, including:
 - Extended chilling times
 - Variability in chilling
 - Batch operation
 - The need for large chill rooms
 - Uneven product loads
 - The heat peak
 - High weight losses

(ii) Blast or Ultra-rapid chilling system

This is the most popular alternative chilling system adopted by the pork industry. This system aims at removing the heat from the pork carcass within 3 to 4 hours.



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- Chilling is normally delivered in two stages: a pre-chilling stage consisting of a conveyerised tunnel operating at sub-zero temperatures; and a subsequent conventional-type chilling regime ("equalising chill")
- The reduction in chilling times is the most obvious advantage resulting in improved operational efficiency through increased throughput
- Rapid chilling results in reduced weight losses
- Disadvantages of blast chilling include:
 - High initial capital investment
 - Detrimental effects on pork eating qualities because of cold shortening (unless electrical stimulation is applied, see below)
 - If any major freezing of the lean occurs, there may be a large increase in drip loss from the retail cut
 - Changes in pork colour (rapidly chilled loins can be darker and slightly less colour-saturated)

Measures to improve meat quality in fast chilling systems

Fast chilling systems are designed to reduce the chilling time and the evaporative weight loss but they may have a serious detrimental effect in terms of meat quality, particularly texture. Pork texture, and more specifically, tenderness, is one of the key characteristics determining consumers' overall liking of pork. Therefore, measures should be taken to maintain pork tenderness. At the slaughterhouse level, three main measures have been proven to be effective when improving pork tenderness:

- Electrical stimulation
- Pelvic suspension
- Ageing



Electrical stimulation is suitable where carcasses will be rapidly chilled, eg 'blast chilling', but not for conventional chilling systems. Pelvic suspension and ageing can be adopted both where fast chilling systems are used and to enhance tenderness under conventional slow chilling regimes.



Electrical stimulation

The beneficial effect of the electrical stimulation on pork tenderness has been widely demonstrated. Electrical stimulation prevents cold shortening as it accelerates post-mortem metabolism in muscle tissues. Ageing rate is also faster, in particular for the muscles which enter rigor mortis earlier (eg the loin). However, the incidence of Pale Soft Exudative (PSE) meat is likely to increase unless rapid chilling is used because it accelerates the pH decline in muscles.

Pelvic suspension

Pelvic suspension consists of hanging carcasses from the aitch bone, rather than from the achilles tendon, after slaughter and prior to the onset of rigor. In addition to pork texture, this measure also improves water-holding capacity of muscles and it reduces drip loss. Furthermore, processing yields (eg brine uptake and retention) can increase in the hindquarter muscles. The major drawbacks of this practice are the increase in chilling space and some health and safety issues in fast pork processing lines.

Ageing

Ageing is the natural process of meat tenderisation post-rigor mortis in which the enzymatic processes in meat break down some of the protein structures holding the meat together and, as a result, tenderness increases (see *Target Pork Quality No4* for further details on this topic).

Novel chilling systems

There is a wide range of alternative chilling systems available, including spray, immersion and ice-bank systems. Of particular interest is ultra-rapid chilling in three stages. This blast-chilling method is reported to substantially improve tenderness. Carcasses are rapidly chilled to a temperature below 15°C in a blast tunnel, followed by an equilibration stage where temperature is maintained at 10-15°C for 6 hours. Finally, carcasses are returned to the blast chilling tunnel for 12 min and placed in an equilibration cold room at 4°C until the next day. This results in reduced drip loss and improved tenderness over traditional blast chilling systems.