Extending the shelf-life of meat and fish products with superchilling

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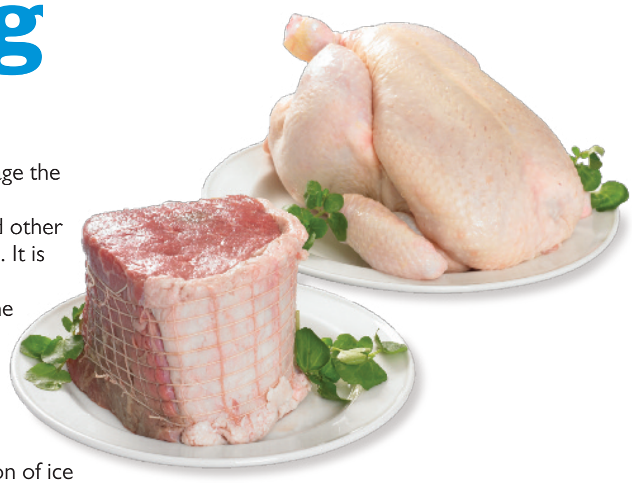


Superchilling is the practice of chilling food to a temperature just below the freezing point of the aqueous phase of a particular product, and then storing it at that temperature. This is generally around -1.5°C to -2°C.

Superchilling is not a novel concept, and was proposed as a method for preserving food approximately 100 years ago. Since then, the majority of research has concentrated on the fishing industry, as this is where the largest perceived benefit has been identified.

The importance of ice

Superchilling well deserves its alternative terms of partial freezing, crust freezing and deep chilling. Some definitions of superchilling use ice fraction as an indicator of the chilled state of the product, however this measurement is more suited to a research environment than the high-throughput requirements of industrial processing. Ice crystals can damage the structure of foods and can cause increased drip loss, softening and other textural changes when defrosted. It is therefore essential that any superchilling process results in the formation of the smallest possible ice crystals, and this can be achieved by freezing the product as swiftly as possible. Swift freezing can also result in dehydration of cells and formation of ice crystals in extracellular spaces. This has a further protective effect. The method used to freeze the product has surprisingly little effect on the final quality of the product. Therefore, existing freezer technology can be used to produce superchilled products without the need for investment in new equipment, although some delicate products may benefit from more rapid freezing.

Effects on shelf life

The data so far indicates that superchilling has the ability to extend the shelf life of some fresh (non-frozen) products without the sensory attributes being affected. The majority of research so far has been performed on fish, with a few studies looking at other foods. There is little data to support shelf life extension of fresh (non-frozen) ready-to-eat foods such as pies or ready meals. Table 1 lists some available data on shelf life extensions reported in the literature.

The microbiological effects of superchilling in terms of spoilage indicate that the rate of growth of the microflora is suppressed, however it does not completely stop microbiological activity. The studies that have compared psychrotrophic counts to mesophilic counts did not detect significant differences between the two.

Table 1. Examples of shelf life extension of superchilled product above that of the equivalent chilled product.

Product	Superchill temperature (°C)	Packaging atmosphere	Shelf life extension (days)
Salmon	-1.5	90% CO_2	11
Mullet	-2.0	Vacuum	3
Japanese seabass	-1.5	40% CO_2 / 30% O_2	4
Cod muscle	-4.0	Air	5
Pork roast	-2.0	Air	98
Salmon	-1.4	Air	17
Salted fresh salmon	-1.0	Air	7
Salmon	-2.0	60% CO_2	11
Cod fillet	-1.5	Air	3
Japanese seabass	-3.0	Air	14
Cod	-2.0	50% CO_2 / 5% O_2	7
Wolf fish	-1.0	60% CO_2	2
Arctic charr	-2.0	CO_2	6
Shrimp	-3.0	Air	6

How is it done?

Superchilling is not a difficult process, and can be achieved using standard blast chillers. Dwell times will be increased compared to chilling, and it follows that the size of the product will affect this. From a legal perspective, superchilling is defined in legislation between a limit for 'chilled' products and 'frozen' products.

The definition of these two states is arbitrarily identified through legislation. According to Council Directive 89/108/EEC as part of EU legislation, frozen food can be kept at -18°C±3°C unless in a retail cabinet, in which case the fluctuation can be as much as 6°C either side of -18°C.

Therefore, an upper limit of -12°C is the boundary below which a product would be considered frozen. In the case of poultry and its preparations, the legislation (Regulation (EC) No 1234/2007) states:

'fresh poultrymeat' means poultrymeat which has not been stiffened at any time by the cooling process prior to being kept at a temperature not below -2°C and not higher than +4°C.

It also states that 'frozen poultrymeat' means poultrymeat which must be frozen as soon as possible within the constraints of normal slaughtering procedures and is to be kept at a temperature no higher than -12°C at any time.

Regulations for foods other than poultry make no mention of storage temperature until the threshold of -12°C is reached, therefore a product containing no poultry could be chilled to any temperature above this and still be classed as chilled (Reg. 853/2004). Therefore, there is a grey area between -2°C and -12°C, where the definitions of 'chilled' and 'frozen' merge into each other.

Recent research

Recent work at Campden BRI (funded by DEFRA and industrial partners) showed the effect of superchilling using a conventional blast chiller did not result in a significant loss in quality compared to the chilled product, a finding which is supported by other research.

At present, it is unrealistic to expect that retailers and consumers are going to be able to keep food at superchilled temperatures without major re-investment in their chilling equipment.

Therefore, it is likely that at some point in the distribution chain, a superchilled product will be tempered to standard chilled conditions before retail.

The Campden BRI project examined the effect of this practice on a range of products, with cook-chill prawns packed in a modified atmosphere showing the greatest promise. Prawns were cooked, superchilled and packed before being sent to Campden BRI for sensory and microbiological shelf life analysis. The product was kept at superchill (-2°C), then it was removed and stored at chill temperature (5°C).

The effect of storing for varying time at

superchill was tested for its effect on a standard 10 day chilled shelf life post-superchill storage. The results of this experiment are shown in Fig. 1.

These results indicate that the standard 10 day chilled shelf life can be kept after six days superchilled storage. The chilled shelf life starts to decrease as superchill shelf life is increased, so a balance must be obtained between an increase in superchill shelf life at the production site, whilst maintaining an acceptable chilled shelf life once released from the site.

Is it safe?

The test shown in Fig. 1 was repeated with a challenging cocktail of Listeria monocytogenes strains added before superchilling.

The results showed no difference in growth of L. monocytogenes over the chilled shelf life of any superchilled product when compared to the chilled version. There was no observed growth during superchilled storage. The implication of this experiment is that superchilled food is no more dangerous in terms of pathogen growth than the chilled version.

Therefore, the same approach to risk assessment is needed to have confidence in the safety of any product that will be superchilled. This may take the form of a challenge test or another test that will show the product is safe.

Another advantage is for products affected by shelf life guidance for psychrotrophic Clostridium botulinum. Storage below the minimum growth temperature for this organism (3°C) allows a shelf life of longer than 10 days (according to Campden BRI Guideline 11) for the duration of the low-temperature storage. A shelf life of 10 days or less would then be applied from the point at which the product temperature rose above 3°C.

Reduced waste

Superchilling has the potential to reduce the amount of waste generated during production, principally due to the longer production runs possible. Further advantages identified by the industrial partners participating in the DEFRA project included a longer Minimum Life On Receipt (MLOR) for retailers, reduced start-up and shut-down losses due to the possibility of longer production runs, and a reduction in overweighting of packs.

There can also be savings in transportation costs, particularly if ice is used to keep product chilled as is the case for fresh fish. Removing ice from the process can result in water and energy savings during production, and allows more product to be packed into a vehicle.

Conclusion

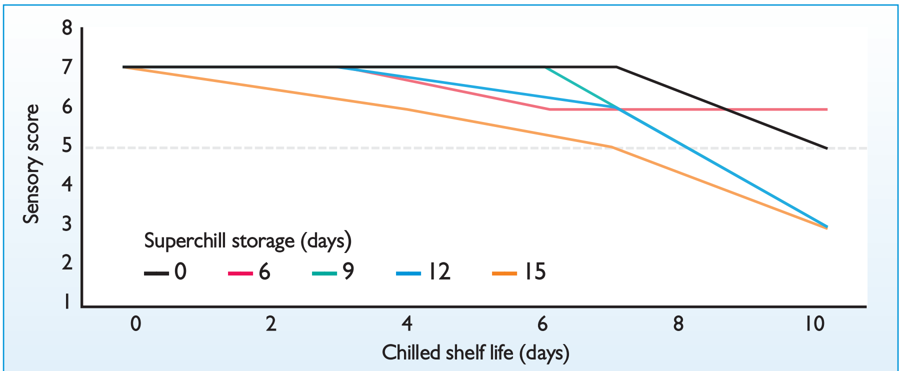
Superchilling, on a practical level, offers a simple method of extending the shelf life of a chilled product by several days. The evidence so far indicates that some products respond to the process more favourably than others, with fish and meat products having been tested most so far.

The effect on ready to eat products such as pies or ready meals is less clear, and this is purely due to lack of evidence. The potential benefits of this technique are likely to be felt by manufacturers, who will be able to better manage stock before releasing it to retailers.

The evidence so far suggests that superchilling introduces no other microbiological risk, is no more dangerous than standard chilling, and safety would be assessed as for any other product.

The food industry is under constant pressure to extend shelf life, and superchilling offers a cost effective and simple method of achieving this. In order to implement this approach for their own products companies would be advised to undertake the usual risk assessment and shelf-life trials for their own product types, however current evidence would suggest that many different products types could have longer shelf life through the use of a superchilling approach. ■

Fig. 1. Chilled sensory shelf life of prawns after 0, 6, 9, 12 and 15 days of superchill storage. Shelf life is deemed to end when sensory score = 5.



References are available from the author on request