Superchilling concepts enabling safe, high quality and long term storage of foods

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Abstract

Superchilling is a concept where the temperature is reduced 1-2 °C below the initial freezing point of the product. This results in a so-called ‘shell freezing’, where a thin layer of ice is produced on the product surface during processing. The small amount of ice formed within the product serves as a heat sink, eliminating the need for ice during storage and transport. As an illustration, chilled haddock fillets have approximately 30 % higher environmental impact potential than superchilled fillets due to the need for ice during storage and transport. During storage, the ice distribution equalizes and the product obtains a uniform temperature and the product appears as fresh. Consumer market analysis gives superchilled products as good as or better quality score compared with chilled products. Experiments on different superchilled and chilled food products shows a prolonged shelf life for all superchilled products compared to chilled products. For superchilled salmon and chicken fillets, the shelf life is 50 % longer compared to chilled reference products based on total count of microorganism and a quality limit of $10^7$ CFU/g. Superchilled experiments have shown that the method is robust and appropriate for implementation to the industry, owing to the fact that ice fractions can vary between 5-20% without being of major importance to the product quality. Superchilling enable safe, high quality and long term storage of foods. The main advantage is the approximate doubling of shelf life for superchilled products compared to chilled products, high product quality, higher yield and the potential for reduced environmental impacts (approximately 30 %) when changing from chilled to superchilled value chains.

Keywords: Superchilling; Quality; Shelf-life; Foods

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Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.

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1. Introduction

Superchilling is a concept where the temperature is reduced 1-2 °C below the initial freezing point of the product. This results in a so-called ‘shell freezing’, where a thin layer of ice is produced on the product surface during processing. The small amount of ice formed within the product serves as a heat sink, eliminating the need for ice during storage and transport. As an illustration, chilled haddock fillets have approximately 30 % higher environmental impact potential than superchilled fillets due to the need for ice during storage and transport [1]. During storage, the ice distribution equalizes and the product obtains a uniform temperature and the product appears as fresh. Consumer market analysis gives superchilled products as good as or better quality score compared with chilled products.

The superchilling concept is not a new invention, and was described as early as 1920 by Le Danois. Later, in the 1970’s and 1980’s, superchilling was mainly studied for transportation of fish at sea. For the last 10-20 years the concept has been under continuous development. Superchilling can be performed by means of several methods, RSW chilling (refrigerated sea water), air chilling in blast tunnels and contact chilling being among the most used. The Norwegian food industry is currently taking on the superchilling concept. In the meat industry, superchilling is used ‘in-house’ in the industrial plant to expand the shelf life of the product, ease the production and storage planning and to extend the sales period for fresh meat. In the fish industry, superchilling of fillets increases the product yield and quality, resulting in more of the raw material being sold as fresh fillets rather than frozen. For both industries, superchilled conditions are applied only for the processing line and initial storage and the advantages related to prolonged shelf life is to this day not fully exploited.

The objective of this work is to point out the main advantages and potential for the superchilling concept to enable safe, high quality and long term storage of foods.

2. Materials & Methods

Several superchilling experiments have been performed on different food products to demonstrate the extended shelf life of superchilled products. The extended shelf life consider both the microbiological and physical changes during superchilling and storage of superchilled products. A calorimetric method for measuring ice fraction has been established, and an online near-infrared spectroscopy (NIR) method for measuring ice fraction is validated for prediction of superchilled salmon [2]. The microbiological growth, by means of CFU (colony forming units) is measured by method NMKL 96 [3]. Other physical changes such as drip loss, water holding capacity and texture are measured by means of standardised methods in order to verify quality changes in superchilled food products compared to chilled products.

3. Results & Discussion

The shelf life of a food product is mainly defined based on a quality limit of $10^7$ CFU/g, above which food is regarded as unfit for human consumption. Figure 1 is based on several experiments on superchilled and chilled food products and summarises the average shelf life for the specific products due to the quality limit of $10^7$ CFU/g.

Figure 1 reveals that the shelf life of superchilled chicken and salmon is 50 % longer compared to chilled product, while superchilled cod obtain 46 % longer shelf life compared to chilled product. Since previous and ongoing research have already shown that superchilling of food products does increase the shelf life and give high quality end-products, the main challenge today is an efficient implementation and optimization of the superchilling processing lines in the different food industries.
4. Conclusion

Superchilling enable safe, high quality and long term storage of foods. The main advantage is the approximate doubling of shelf life for superchilled products compared to chilled products, high product quality, higher yield and the potential for reduced environmental impacts (approximately 30 %) when changing from chilled to superchilled value chains.

Acknowledgements

The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement nº 245288. The study was also supported by the Norwegian Research Council, grant no 178280/10 Competitive Food Processing in Norway and grant no 195182/S60 CREATIV.

Reference


Presented at ICEF11 (May 22-26, 2011 – Athens, Greece) as paper INM1318.