Development and experimental validation of SMAS - a TTI based chill chain management system

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Application of an optimised quality and safety assurance system for the chilled distribution of chilled products requires continuous monitoring and control of storage conditions, from production to consumption. Time Temperature Integrators (TTI) allow such control down to product unit level. A novel chill chain management system, coded SMAS, based on the real quality and risk profile of products, was developed. SMAS uses the information from the TTI response at designated points of the chill chain, ensuring that the temperature-burdened products reach consumption at acceptable quality level.

The effectiveness of the TTI based SMAS system was evaluated by running a large number of chill chain scenarios using a Monte Carlo simulation approach. Field test experiments to demonstrate and quantify the improvement at the time of consumption in comparison to the conventional First In First Out (FIFO) rule, were also conducted. Modified atmosphere packed fresh pork cuts, were used in the chill chain simulation. On half, enzymatic TTI were attached at the time of packing. All products entered the regular transportation route to the central distribution center of the manufacturer and then were stored in the research food laboratory, in programmable cabinets simulating the conditions of the real chill chain to the point of consumption. Products were split at the designated decision time and followed a simulated path to a "local" and a "distant" market. The products without TTI were split randomly. The information from the ones with TTI was translated into the integrated temperature history and quality status of each product and their further handling was based on this data. Microbiological measurements of all products at "consumption time" were conducted. According to the final microbiological measurements the spoilage profile of the TTI bearing products was significantly improved. 21% of samples that were handled randomly were spoiled at the time of consumption (LAB>log7) compared to less than 10% handled with the SMAS approach, demonstrating the usefulness of TTI monitoring and the applicability of SMAS for improving the chill chain.