Development of a decision support tool for different meat supply chains

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Abstract

Storage temperature is one of the most influencing factors on the quality and safety of meat and meat products. Even short interruptions, which often occur in cold chains, lead to significant reductions in the shelf life of perishable products (Bruckner et al., 2013). For the different participants these interruptions and the effect on shelf life are often not visible.

Therefore, a controlled cold chain with respect to temperature has a high relevance regarding shelf lifetimes, food safety and quality. But up to now, temperature abuses in the chain have often been indistinguishable due to a lack of effective monitoring systems (Raab et al., 2008). As a consequence, evaluating the real quality status of meat at each control point within the supply chain is difficult, since short interruptions of the cold chain, especially in the first days of storage, do not immediately lead to remarkable sensory changes. Even if the temperature profile of a product is known, the participants of the chain are usually not aware of the effect of different time and temperature variations on the product quality and the remaining shelf life.

One solution to provide the participants of the chain with more precise information about the real quality and the remaning shelf life of a product is the combination of predictive food models and temperature data in the chain. To get precise information about the quality of a product a comprehensive monitoring of the product temperature along the entire supply chain is from vital importance. But up to now temperature monitoring in meat supply chain focuses mostly on controlling environmental temperature, which normally differs from the product temperature. Therefore the objective of this study was the development of a decision support tool (DST) to predict the remaining shelf life in different steps of the supply chain based on the real product temperature.

A three step approach was chosen to build up the DST for modified atmosphere packaged pork meat. In a first step a model was developed to predict the shelf life based on product temperature. Microbial and sensory investigations of the product in pretests showed that the best quality parameter to describe the spoilage process is a weighted sensory index (SI). In several storage tests the time and temperature dependency of the SI was determined under different constant and dynamic temperature conditions. Based on the results the shelf life model was developed using a linare function for the primary model and the Arrhenius function for the seconday model. An excel tool was developed where both models were combined (tertiary model). This allows calculating the reaming shelf life based on the temperature conditions.

The second step was the development of a heat transfer model to predict product temperature based on environmental temperature. Storage tests in a climate chamber were conducted under dynamic temperature conditions where the temperature changes on pallet level were investigated. Data loggers were used to measure meat and environmental temperature during the trials. The

increase and decrease in temperature was fitted with an exponential function according to Newton's law of cooling to determine characteristic model parameters for each position in the pallet.

In a last step both models were combined to predict shelf life based on environmental temperature, which was the basis for the development of the DST. The DST, providing the participants of the chain with information about the remaining shelf life and the integrity of the cold chain, is visualized in a form of a traffic light (Fig. 1).

A green light illustrates that the cold chain was within its limit and the reduction of shelf life is less than 5%. A yellow light signals that specific time –temperature thresholds are overstepped and that the shelf life reduction is between 5-10%. If the cold chain interruptions lead to a reduction of shelf life of more than 10%, or if a temperature threshold is exceeded for a certain time period, e.g. regulatory temperature limits, a red light signals the chain actors an alert to intervene.

The threshold values can be adapted to different products and chains.

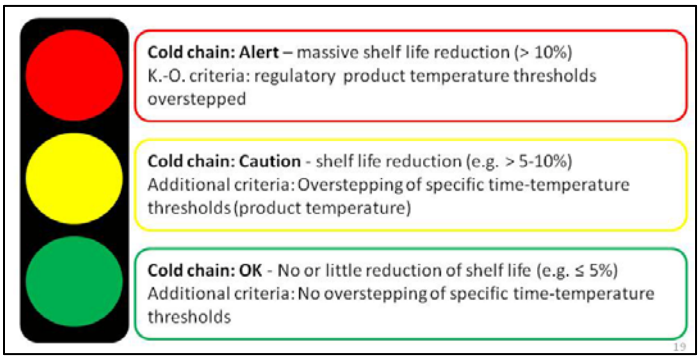

Fig.: 1 Decision support tool and possible signal thresholds

In the study it was shown that shelf life can be predicted based on environmental temperature. The application of the DST allows quality based distribution of the product and, thus, enables intelligent storage management. The system can flexibly be adapted to other products and supply cnains.

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Literature

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