P-12-18

Improving the sustainability of meat supply chains by the application of novel packaging solutions (#428)

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Introduction

Food packaging is of essential importance for the protection, distribution, preservation and presentation of the product. Since fresh meat is highly susceptible to microbial contamination and spoilage, different packaging strategies have been developed to preserve a high quality and safe product. The prolongation of shelf life is one major goal for approaches to the prevention of food waste and loss (FLW). Despite this benefit, the environmental impact of packaging waste is discussed intensely. This study aimed at the evaluation of different packaging technologies to preserve meat, prolong the shelf life, improve the food safety and reduce FLW. For assessing the sustainability of food packaging, the potential to reduce food waste was analyzed as a ratio of the environmental impact of the packaging.

Methods

Over 300 storage trials were conducted to evaluate the potential of various packaging strategies (aerobe, modified atmosphere (ma), vacuum, active, intelligent) for different fresh meat products (poultry, pork, lamb and beef). During the trials, the products were stored under temperature controlled conditions according to the legislative recommendations of the particular product. Total viable counts (TVC) and typical spoilage bacteria (*Pseudomonas* sp., *Brochothrix thermosphacta*, Lactobacilla, Enterobacteria) were detected by classical enumeration techniques. A predictive modeling approach was conducted to assess the shelf life of the product and determine the potential to reduce FLW. The environmental impact of FLW reduction was calculated in relation to the resources normally used for meat production (H_2O, animals, CO_2, feed). A Life Cycle Assessment (LCA) was conducted to characterize and evaluate the packaging material according to the food protection, recyclability, resource efficiency and sustainability.

Results

The results of the storage trials confirmed that vacuum and ma-packaging significantly prolonged the shelf life of fresh meat in comparison to aerobe packaging. A specific modulation of the utilized atmosphere supported the growth inhibition of particular pathogen bacteria. In comparison to conventional ma-packaging, active packaging showed the potential to further prolong the shelf life of the product by one to two days. The storage trials revealed that the variability of microbial counts is high and knowledge about the initial contamination is crucial for appropriate shelf life modeling. Intelligent packaging offers the opportunity to implement a flexible shelf life date by reflecting the real product status within the supply chain. The results showed that innovative packaging solutions have the potential to prolong the shelf life of fresh meat products up to five days. As an example for chicken in a national supply chain, a prolongation of shelf life by two days results in a FLW reduction by 15%. According to the research calculation, this is equivalent to 7.279.881animals, 94.638 t feed, 203.837 m^3 of water and 14.559.762 CO_2 equivalent per year.

Conclusion

Food packaging has a high potential to optimize meat supply chains according to sustainability aspects. Selecting the appropriate packaging solution for the specific meat product is crucial for the reduction of FLW. Additionally, the structure of the food supply chain has to be taken into account for estimating the potential to reduce FLW in different steps of the chain. In comparison to conventional packaging, active and intelligent packaging technologies offer enhanced potential to prolong shelf life, display the actual quality and safety status of the product and optimize cold chain management. Thus, the resource efficiency and sustainability of the meat production sector can be significantly increased, leading to substantial savings of animals, feed, H_2O and CO_2. Additionally, the reduction of FLW results in a lower volume of supplied packaging units and packaging material. For a comprehensive sustainability analysis, the recyclability or compostability as well as circularity of the packaging material is of major importance.

Notes