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## Active and Intelligent Packaging Systems for a Modern Society

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### Abstract

Active and intelligent packaging systems are continuously evolving in response to growing challenges from a modern society. This article reviews: (1) the different categories of active and intelligent packaging concepts and currently available commercial applications, (2) latest packaging research trends and innovations, and (3) the growth perspectives of the active and intelligent packaging market. Active packaging aiming at extending shelf life or improving safety while maintaining quality is progressing towards the incorporation of natural active agents into more sustainable packaging materials. Intelligent packaging systems which monitor the condition of the packed food or its environment are progressing towards more cost-effective, convenient and integrated systems to provide innovative packaging solutions. Market growth is expected for active packaging with leading shares for moisture absorbers, oxygen scavengers, microwave susceptors and antimicrobial packaging. The market for intelligent packaging is also promising with strong gains for time-temperature indicator labels and advancements in the integration of intelligent concepts into packaging materials.

Keywords: active, intelligent, packaging, shelf life, muscle foods

### 1. Introduction

Food packaging technology is continuously evolving in response to growing challenges from a modern society. Major current and future challenges to fast-moving consumer goods packaging include legislation, global markets, longer shelf life, convenience, safer and healthier food, environmental concerns, authenticity, and food waste (Kerry, 2014). Every year a growing amount of edible food is lost along the entire food supply chain. Annual food waste generation estimates in Europe are around 89 million tonnes varying considerably between individual countries and the various sectors (European Commission, 2012a). Spoilage of raw meat along the food supply chain (production, retailers, consumers) represents a loss which could be as high as 40% (Sperber, 2010). Packaging optimisation strategies such as varying pack sizes to help consumers buy the right amount, and designing packaging to maintain food quality and increase its shelf life have been proposed to reduce food waste (European Commission, 2012a).

Food safety is a global priority and one of the major objectives of the current food legislation. However, microbiological risks of food products are even today one of the main sources of foodborne illnesses. Listeriosis constitutes the highest EU foodborne illness showing a high mortality rate around 13%. The fact that *L. monocytogenes* can

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