



OPPORTUNITY

12

SCOPE **TRANSITIONAL**

UNCERTAINTIES

Technology, Values

MEGATRENDS

Materials revolution

TRENDS

- Biomaterials
- Biotechnology
- Food Innovation
- Mobilising Innovation
- Sustainable Waste Management

SECTORS IMPACTED

- Agriculture & Food
- Chemicals & Petrochemicals
- Consumer Goods, Services & Retail
- Health & Healthcare
- Materials & Biotechnology

What if expiry dates were unnecessary?

A WARNING GLOW GenAI

Bioluminescent food packaging materials detect food deterioration and contaminants, extending shelf life and reducing waste, transforming food safety in retail, restaurants, and homes.





WHY IT MATTERS TODAY

Some 600 million people a year (almost 1 in 10 people worldwide) are affected by contaminated food.³⁹¹ Food safety failures caused 420,000 deaths and a loss of 33 million disability-adjusted life years in 2010.³⁹² Over 40% of those carrying the food-borne disease burden are children under the age of five, 125,000 of whom die every year.³⁹³ The losses to productivity and in medical costs are an estimated \$110 billion per year.³⁹⁴

Food can be damaged or contaminated along the entire value chain, from processing to storage and transport and in stores. The main sources of food contamination are toxins or microorganisms (e.g. chemicals, viruses, bacteria, or parasites). The World Health Organization identifies over 200 diseases related to contaminated foods.³⁹⁵

Current food labelling systems use the precautionary principle, often using sell-by and use-by dates that are too cautious, meaning retailers and consumers dispose of food unnecessarily. Reported in 2021, around 931 million tonnes of food are wasted each year, of which 61% is in households, 26% in restaurants, and 13% in retail.³⁹⁶

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in retail



in restaurants



in households



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Packaging materials include bioluminescent elements to detect and signal deteriorating foodstuff and/or the presence of toxins or harmful microorganisms. As several mechanisms are behind bioluminescence – the natural production and emission of light by living organisms – proteomics, genomics, and bioinformatics advance how underlying proteins and enzymes can be used in packaging materials for food safety.³⁹⁷

This helps avoid restrictive expiry dates,³⁹⁸ extends the shelf life of food items, and reduces waste. Crates of staples like rice or wheat, for example, can be equipped with bioluminescent markers that indicate the presence of contaminants such as pesticides or metals. This technology elevates safety standards in retail and restaurants by alerting staff to spoiling food and enables consumers to monitor food safety at home, further minimising waste without having to throw out food early. Additionally, this smart bioluminescent packaging can be adapted for other sensitive products, such as pharmaceuticals or cosmetics, and can also aid in monitoring of environmental impacts.³⁹⁹

BENEFITS

Bioluminescent packaging offers a universally understandable indicator of food safety, protecting health and reducing food waste, contributing to improved food security.

RISKS

Malicious or accidental damage to packaging might trigger false positives or even prevent bioluminescence in order to attack food retailers or communities. Biomaterials used to create bioluminescence may contaminate food, and upon reaction with food, cause harmful by-products.

