ULST Timisoara
Multidisciplinary Conference on Sustainable Development
15-16 May 2025

2025 MULTIDISCIPLINARY CONFERENCE ON SUSTAINABLE DEVELOPMENT

BALANCING SUSTAINABILITY AND PRESERVATION: HOW NEW-GENERATION PACKAGING CUTS FOOD WASTE AND ENVIRONMENTAL IMPACT

Ioana-Alexandra ALEXE, Gabriela Elena STAN, Gratziela-Victoria BAHACIU

Faculty of Animal Production Engineering and Management, University of Agronomic Sciences and Veterinary Medicine, Bucharest, Romania

ABSTRACT

Food packaging plays a vital role in preserving food quality and safety, but its environmental impact calls for sustainable innovation. This study explores how packaging can reduce waste and enhance sustainability through bio-based polymers, active materials, and intelligent indicators. Lifecycle assessments show that sustainable choices must balance environmental costs with the benefits of waste reduction. Design strategies like portion control, oxygen-scavenging films, and improved barriers help reduce spoilage and increase supply chain efficiency. By applying circular economy principles, the study emphasizes collaboration across sectors to turn packaging into a tool for minimizing food and material waste.

MATERIALS AND METHODS

This current research integrates recent publications identified through comprehensive searches in scientific databases including Science Direct, Web of Science (accessed via Enformation), and Google Scholar. Additionally, data were collected from stakeholders sources, particularly reports and databases provided by the Food and Agriculture Organization (FAO), the European Food Safety Authority (EFSA) and the European Commission (EC).

INTRODUCTION

In a global context marked by climate change, food loss, and environmental pressure, food packaging plays a key role not only as a protective barrier but also as a solution for extending shelf life, reducing waste, and maintaining product quality. Although conventional plastic films offer advantages such as low cost and efficiency, their environmental impact has driven the shift toward active, smart, and biodegradable packaging. Contrary to common perception, packaging can significantly reduce environmental impact by preventing food loss, which often has a greater ecological footprint than the packaging itself. Renewable-resource-based materials like PLA or thermoplastic starch provide sustainable alternatives, though they often show lower performance than synthetic options. Current research focuses on improving these materials through functional additives and advanced processing technologies . The main challenge remains finding a balance between performance and sustainability through an integrated approach that meets both industry requirements and consumer expectations.

RESULTS AND DISCUSSIONS

Figure 1. Integration of Biodegradable and Bioactive Polymers into Modern Packaging Systems: A Sustainable Approach for Reducing Environmental Impact and Extending the Shelf Life of Food Products

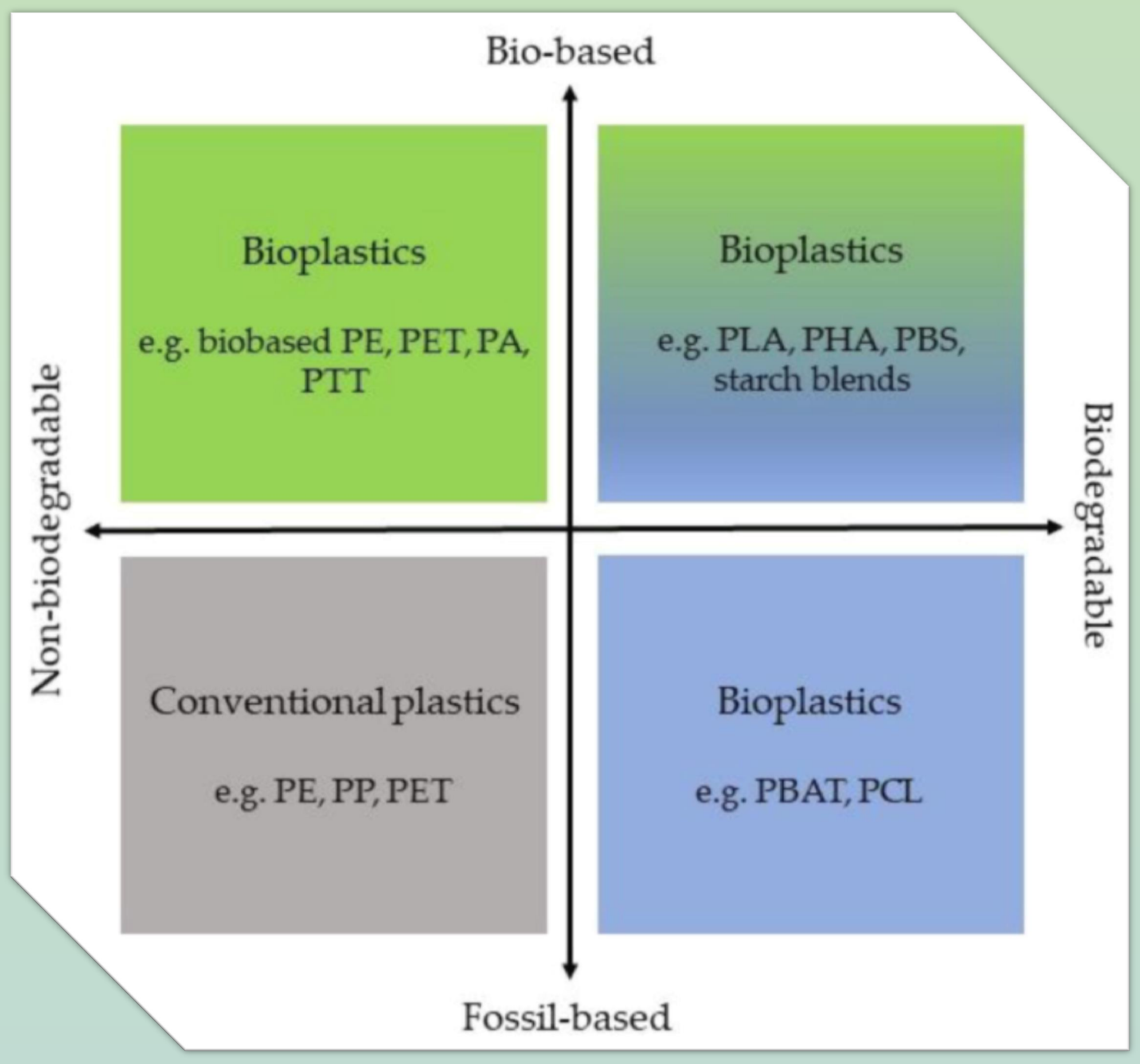

Figure 2. Classification of plastics used for packaging applications. Adapted from Polyamide (PA), poly butylene adipate terephthalate (PBAT), poly butylene succinate (PBS), poly butylene succinate (PBS), poly caprolactone (PCL), poly ethylene (PE), poly ethylene terephthalate (PET), poly hydroxyalkanoate (PHA), poly lactic acid (PLA), poly propylene (PP), poly trimethylene terephthalate (PTT).

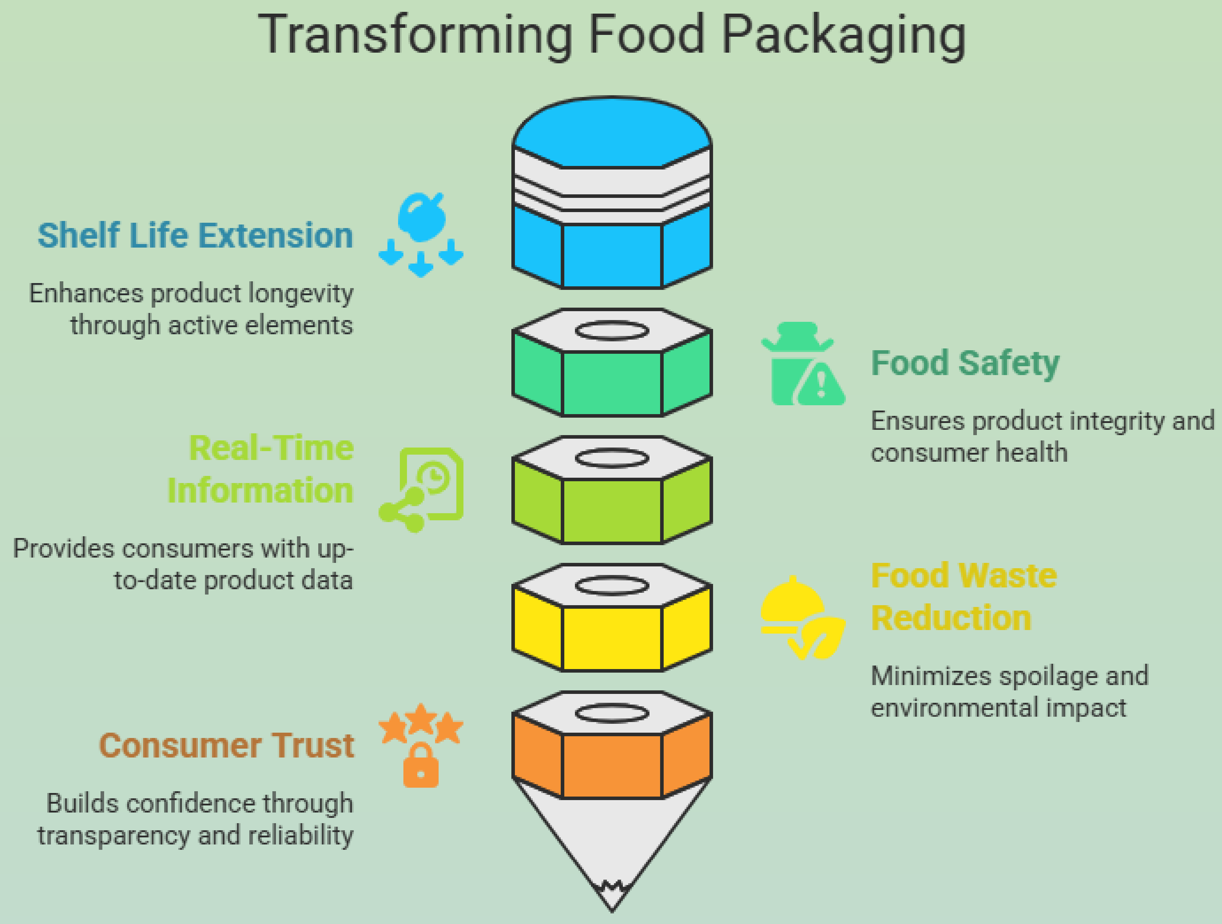

Figure 3. Leveraging Active and Intelligent Packaging Technologies: A Multidimensional Approach to Shelf Life Extension, Enhanced Food Safety, Waste Reduction, and Strengthened Consumer Trust

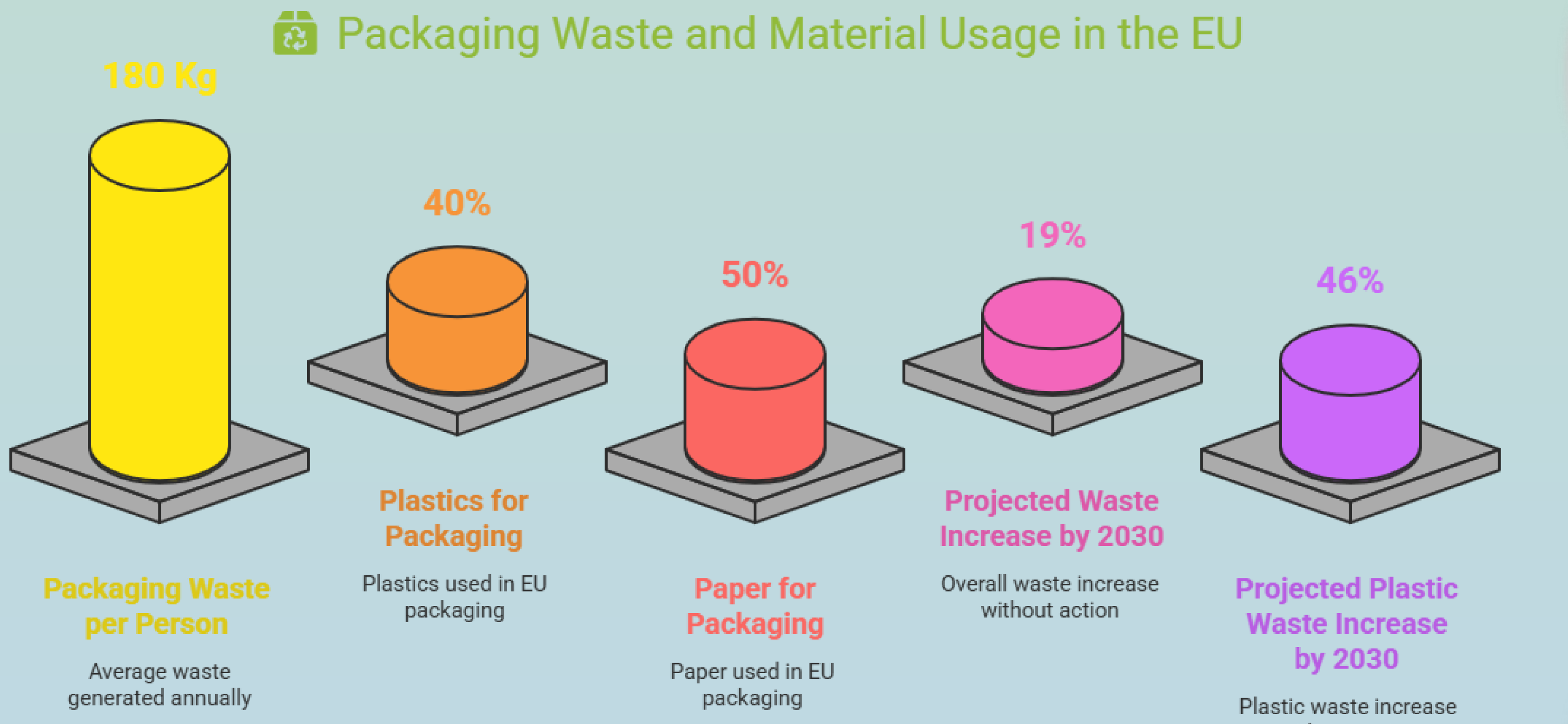

Figure 4. Packaging waste and material usage in the EU

CONCLUSION

The integration of bio-based, biodegradable, edible, and smart packaging systems represents a pivotal advancement in aligning food preservation technologies with sustainability objectives. Packaging solutions incorporating active compounds and intelligent indicators, particularly those derived from agro-industrial byproducts, contribute significantly to shelf life extension, food waste reduction, and circular resource utilization.

Life Cycle Assessment (LCA) data confirm that sustainable packaging must balance environmental trade-offs with functional performance, particularly in terms of barrier properties, compostability, and system compatibility. The environmental benefit is maximized when such packaging operates within a well-developed end-of-life infrastructure and supports food system efficiency. Future development should prioritize material optimization, digital integration (e.g., Internet of Things for traceability and quality monitoring), and regulatory harmonization. Multidisciplinary collaboration remains essential to transform food packaging into a strategic enabler of environmental and food system resilience

ACKNOWLEDGEMENTS

This research work was carried out with the support of the Faculty of Animal Production Engineering and Management, University of Agronomic Sciences and Veterinary Medicine Bucharest.