Market Implementation of Active and Intelligent Packaging – Opportunities from a Socio-economic Perspective

Presented by: Dr. Johanna Lahti  
(Tampere University)

Co-authors: Sanne Tiekstra (Bumaga BV), Mieke Buntinx (University of Hasselt)

Introduction

• **Bioeconomy** is based on the shift from fossil to renewable raw materials to respond to the challenges of climate change, ecological scarcity and depletion of natural resources.

• **Packaging** plays an important role in the bioeconomy.
Package development

- **Packaging materials are usually multilayer structures**
  - “Less is more” – optimisation of materials
  - Lighter packages save energy and environment

- **Circular economy/bioeconomy: biodegradability, compostability, environmentally friendly, recyclability, re-use....**
  - Renewable alternatives for oil-based (non renewable) materials

- **Trends in packaging industry (e.g.):**
  - Internet shopping is increasing
  - Delivery chains are evolving
  - Food losses should be prevented
  - Product safety/authenticity

- **The demand for high quality active and intelligent packaging (AIP) concepts is constantly increasing.**

---

COST Action FP1405 ActInPak

- **COST Action FP1405 ActInPak was created to develop a knowledge-based network on sustainable, active and intelligent fibre-based packaging in order to overcome current technological, industrial, and social limitations that hinder the wide deployment of existing and newly developed solutions in market applications.**

- **Most of the current active or intelligent packaging solutions are plastic-based, so there is a clear demand for renewable and sustainable AIP solutions to create new packaging materials and concepts.**

http://www.actinpak.eu/
Active and Intelligent Packaging

- **Intelligent packaging**: Monitors the condition of packaged food or the environment surrounding the food
  - For example indicators, NFC, smart labels and sensors

- **Active packaging**:
  - Intended to extend the shelf-life or to maintain or to improve the condition of packaged food.
  - They are designed to deliberately incorporate components that would release or absorb substances into or from the packaged food or the environment surrounding the food.
  - For example releasing and scavenging systems

- **Smart packaging**: Overarching term to address both active and intelligent packaging at the same time.


Bio-based materials for AIP

- The use of bio-based materials in packaging decreases the dependence on fossil fuels.

- **Wood based biomass** that is available in a large scale offers attractive “green” polymers.

- Also **biopolymers** that are based on agricultural or other waste streams offer interesting alternatives for traditional oil-based polymers.
Wood-based polymers

- **Wood based polymers, cellulose and lignin**, have inherent properties that can be utilized in active and intelligent packaging. **Piezoelectricity** is a fundamental property of cellulose. The monoclinic non-centrosymmetric crystal structure of Cellulose II enhances the piezoelectricity and may be used as a sensor and an actuator in intelligent packaging.
- The polyphenolic chemical structure of lignin with aromatic rings provides **antibacterial and radical scavenging** functions for it. These properties may be exploited in active packaging.
- Cellulosic materials have also been observed to have good **oxygen barrier** properties.

Ref. Lahti, J. et al, Tappi Place 2017

Biodegradable polymer for packaging applications

- **Polyhydroxyalkanoate (PHA)** is a linear polyester naturally occurring as a result of bacterial fermentation of sugar.
- There are over 150 different PHA monomers → many different material properties
- PHA can be derived e.g. from sugar beets
- "spheres" in white represent the MINERV-PHA™s biopolymer obtained from sugar beets → Recovery of PHAs

Ref: www.bio-on.it
BioBarr H2020 project develops new bio-based food packaging materials with enhanced barrier properties

- MINERV-PHA™ is based on renewable raw materials, i.e. produced from side streams of sugar production (sugar co-products).
- Polymer is biodegradable (Vinçotte)
- Polymer can be processed with existing extrusion equipment and is suitable for injection and extrusion methods for the production of coatings and objects.

http://www.biobarr.eu/
GA. No. 745586

Active and Intelligent Packaging

- Developments of new fibre-based packaging materials with active and intelligent features offer huge potential, as AIP can help to optimise the supply chain, increase food shelf life and consumer consciousness of food utilisation.
- However, very few of the potential and existing solutions currently have been able to reach the market.
- Within this multidisciplinary COST Action platform, both science and industry gathered to gain insights in the barriers towards market introduction of active and intelligent solutions in packaging industry.
- Based on the collaboration, roadmaps were created to direct future activities in the field.
- In the following, some of these insights are presented especially from the socio-economic perspective.
Final roadmap of ActInPak

• A more detailed version can be downloaded on http://www.actinpak.eu/roadmap-wg2/
Potential implementation of AIP – Socio-economic view

• The main overarching findings that are to be most influential in successful market implementation on socio-economic level:
  i) gap between science and industry
  ii) cooperation between the producing stakeholders within the value chain
  iii) gap between industry and consumer
  iv) market drivers that affect developments

Socio-economic view 1(2)

i) Gap between science and industry
  ➢ There is a lack of awareness and knowledge on AIP, its benefits, added value, function, and impact.

ii) Cooperation between the producing stakeholders within the value chain
  ➢ It is very important (and challenging) to identify the whole value chain of the product in concern, and try to identify who are the key decision-makers.
  ➢ Costs vs. revenues ➢ The benefit of active packaging can be found in reduced food loss and waste, and for intelligent packaging this benefit lies in more proved safety or interaction between different parts of the value chain
  ➢ Challenge of availability of AIP solutions
Socio-economic view 2(2)

iii) Gap between industry and consumer
- Lack of awareness → Informing and educating consumers
- There should not be room for misunderstanding

iv) Market drivers that affect developments
- Many brand owners and food manufacturers position sustainability as a key factor in their strategy
- Consumer awareness
- Internet-of-Things

Acknowledgements

• The authors gratefully acknowledge the support provided by COST (European Cooperation in Science and Technology) Action FP1405: Active and intelligent fibre-based packaging – Innovation and market introduction (ActInPak), for promoting the collaboration between the authors.
Thank You!

Presented by:
Dr. Johanna Lahti
Tampere University
johanna.lahti@tuni.fi