NOVEL PACKAGING FOR BAKED GOODS

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OUTLINE

• Packaging trends and next packaging generation
• Spoilage of baked goods
• Shelf-life extension of baked goods
• Novel packaging for shelf-life extension of baked goods: active packaging
PACKAGING TRENDS & NEXT PACKAGING GENERATION
To be sustainable

Safe and high quality food

Food waste reduction

3D-printing

E-commerce

New food processing technologies

Food shelf-life extension

Social media integration
PACKAGING TRENDS

• Environmentally-friendly packaging
• Convenient packaging
• Tamper-evident packaging
• Light-weight packaging
• Small formats
• Flexible packaging/Stand-up pouch
• Packaging that delivers safe and fresh food: active packaging and intelligent packaging
• Packaging that communicates: intelligent packaging
• Personalized packaging
• etc.
PACKAGING TRENDS

• Convenient packaging

It’s a pouch. It’s a bowl. It’s a convenience that consumers will crave. Shelf-stable retort pouch for Ready Meals from Campbell Soup make microwave heating and subsequent eating quick and easy, especially away from home. The pouch self-vents, making it effortless to heat up the food. Once hot, an easy-open tear converts the pouch into an eat-from bowl, so people can enjoy a hot and tasty meal at work or home, work or wherever.

http://www.packagingdigest.com/flexible-packaging/6-fabulous-flexible-packages-win-top-awards-2016-03-01
PACKAGING TRENDS

• Small formats
  – Smaller households, grab-and-go sector, convenience, health, etc.


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PACKAGING TRENDS

• Flexible packaging/Stand-up pouch

Cover Feature: Executive Forecast

Executive Forecast of the Flexible Packaging Industry 2016
Momentum in the Flexible Packaging Market to Spur Continued Growth

February 1, 2016

The flexible packaging market is likely to grow and continue to offer solutions that meet consumer needs. The future is flexible.

THE FUTURE IS FLEXIBLE
Continued growth, brand value, convenience and benefits play a part.

by MARLA DONAHUE, president and CEO of the Flexible Packaging Association

PACKAGING STRATEGIES (OCT 2016)

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PACKAGING TRENDS

• Flexible packaging/Stand-up pouch

2017 & 2018: THE SAME

WHY?

• Eliminate the need for spoon (convenience)
• Lighter (less material)
• Easier to hold and handle
• Easier to take anywhere
• Resalable lid
• More resistance to breakage
• More space for product information,
  Growing E-commerce, etc.

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PACKAGING TRENDS

• Personalized packaging

PACKAGING TRENDS

• Packaging that communicates: intelligent packaging
  • Packaging technology that records, regulates, or controls the condition of the food product by sensing the environment inside or outside the package to ensure quality and safety during transportation, distribution, and/or retail, or that communicates another type of information related to the packaged perishable product (Almenar, 2018. Innovations in packaging technologies. In: Beaudry, RM, Gil, M.I., editors. Controlled and Modified Atmosphere Use for Fresh and Fresh-cut Produce. Elsevier (In press)).

• Types:
  • Tracking devices
  • Sensors
  • Indicators
  • etc.
PACKAGING TRENDS

• Packaging that communicates: intelligent packaging

PACKAGING TRENDS

• Packaging that communicates: intelligent packaging

http://www.brandpackaging.com/articles/85885-crown-uses-photochromic-inks-on-coors-l
PACKAGING TRENDS

• Packaging that delivers safe and fresh food: active packaging and intelligent packaging

• TODAY’S MAIN TOPIC: ACTIVE PACKAGING
NEXT PACKAGING GENERATION

• Packaging changes resulting from current market changes:
  • Clean label
  • E-commerce
  • 3D printing
NEXT PACKAGING GENERATION

- Packaging changes resulting from current market:
  - Clean label
  - It is driving new product innovation
    - Need for new packaging including redesign of materials, shapes, and labels.

https://www.foodengineeringmag.com/articles/97005-antimicrobials-for-clean-labels?v=preview
NEXT PACKAGING GENERATION

Packaging changes resulting from current market

Amazon on creating ecommerce packaging that’s great for all: customers, companies and the environment


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NEXT PACKAGING GENERATION

• Packaging changes resulting from current market changes:
  • 3D printing
    • 3D-printing is currently used for prototyping of molds for package production but not for the production of the packages.
  • Personalized 3D-printed packaging
    • It will take a while for 3D-printing to be the technology used for the production of flexible packaging (the possible materials still need to be explored and the process is too slow and expensive).

SPOILAGE OF BAKED GOODS
SPOILAGE OF BAKED GOODS

- Main spoilage reactions affecting the shelf life of baked goods:
  - Lipid oxidation
  - Microbial growth (mainly molds)
  - Moisture loss/gain
    » Textural changes
    » Staling (retrogradation)
    » Fat bloom
    » Chocolate bloom
SHELF-LIFE EXTENSION OF BAKED GOODS
SHELF-LIFE EXTENSION OF BAKED GOODS

- Lipid oxidation -> oxygen reduction
- Microbial growth (mainly molds) -> oxygen reduction or use of an antimicrobial
- Moisture loss/gain
  - Textural changes
  - Staling (retrogradation)
  - Fat bloom
  - Chocolate bloom

Spoilage

Water control
NOVEL PACKAGING FOR SHELF-LIFE EXTENSION OF BAKED GOODS: ACTIVE PACKAGING
DEFINITION

• AP can be defined as the packaging technology where certain additives, known as “active compounds,” are incorporated into the packaging material or placed within the packaging container in order to interact directly with the perishable product and/or its environment to extend its quality and/or safety (Almenar, 2018. Innovations in packaging technologies. In: Beaudry, RM, Gil, MI, editors. Controlled and Modified Atmosphere Use for Fresh and Fresh-cut Produce. Elsevier (In press)).
TYPES OF ACTIVE COMPOUNDS

• Active compounds can be grouped into two types depending on their properties:
  
  • Scavenging compounds (oxygen, moisture, ethylene, etc.)
  
  • Releasing compounds:
    ✓ Active releasers (carbon dioxide, ethanol, etc.)
    ✓ Controlled releasers (antimicrobials, etc.)
EXAMPLES OF ACTIVE COMPOUNDS

Highly porous structures

Zeolite 13X
science.uwaterloo.ca

Activated charcoal

Basolite™ A520
Al octahedral blue, O red, C gray.
Hydrogen atoms have been omitted for clarity. Alvarez et al. 2015. Angew. Chem. Int. Ed. 54, 3664–3668.

Basolite™ C300
ACTIVE COMPOUND LOCATION

- In AP, the active compound can be placed inside the package along with the product to be packed (e.g., in sachets or labels (c)) or can be part of the materials that form the package itself (e.g., blended in the bulk polymer matrix (a), applied to the package as a coating (b), integrated in the ink used for printing) (Almenar, E.; Wilson, C 2016. Advances in packaging fresh produce. Food Science & Technology, 30 (3): http://www.fstjournal.org/features/30-3/packaging-fresh-produce)
OXYGEN-SCA VEN GING PAC KAGING


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TYPES OF ACTIVE PACKAGES

• A few examples that are suitable for baked goods:

  – Oxygen-scavenging packaging
    – To minimize lipid oxidation
    – Available in the market place
  – Antimicrobial packaging
    – To inhibit or reduce fungal growth
    – Currently under development
  – Modified humidity packaging
    – To control moisture loss/gain
    – It will be commercialized/used within the next years
OXYGEN-SCAVENGING PACKAGING

• DEFINITION:

• Type of active packaging with the capability of scavenging O\textsubscript{2} to obtain optimal O\textsubscript{2} levels for food over storage (Almenar, 2018. Innovations in packaging technologies. In: Beaudry, RM, Gil, MI, editors. Controlled and Modified Atmosphere Use for Fresh and Fresh-cut Produce. Elsevier (In press)).

• This type of packaging couples the O\textsubscript{2} scavenging capability of the active compound with the packaging material permeability and the food characteristics to control in-package O\textsubscript{2} levels.
OXYGEN-SCAVENTING PACKAGING

• WHEN TO USE:
  • To reduce oxidation of lipids and vitamins, produce respiration, etc.

• WHY TO USE:
  • It can reduce the O₂ concentration to very low levels (even less than 0.01%) which are impossible to achieve in gas flushing or vacuum packaging operations.
  • The majority of the currently commercially available O₂ scavengers contain iron powder due to its high O₂ scavenging capacity (1 g of iron reacts with 300 mL of O₂).

• MECHANISM OF ACTION:
  • Based on chemical reaction with O₂ to prevent it from reacting with the product.
OXYGEN-SCAVENTING PACKAGING

Figure 1. Hexanal accumulation in the headspace of a package containing a moisture and oxygen sensitive, dry, particulate product during accelerated storage (30°C, 65%RH).
ANTIMICROBIAL PACKAGING

• DEFINITION:
  • Active packaging with the capability of reducing microbial growth to enhance food quality and safety over storage.
  • Antimicrobials can be either volatile or non-volatile.
ANTIMICROBIAL PACKAGING

• MECHANISMS OF ACTION:

DIFFUSION + EVAPORATION
ANTIMICROBIAL PACKAGING

• WHEN TO USE:
  • To reduce or inhibit the growth of bacteria, molds, and yeasts.

• WHY TO USE:
  • The direct addition of the antimicrobial on the food product surface by dipping or spraying may result in a rapid diffusion through the food matrix that limits its effect on surface microorganisms.
  • It ensures the exposure of the food product to antimicrobial contents matching those of microbial growth for the required storage period (more effective and cost efficient solutions).
Mechanism de action: **DIFFUSION + EVAPORATION**

Joo, Merkel, Auras, Almenar.  
• Mechanism de action: **DIFFUSION + EVAPORATION**


**E. Coli (control)  E. Coli (ICs)**
• Mechanism de action: **DIFFUSION + EVAPORATION**

**Figure 2.** Left: (-○-) Inhibition of the growth of the postharvest decay fungi *Alternaria solani*, *Aspergillus niger*, *Botrytis cinerea*, *Colletotrichum acutatum* and *Penicillium sp.* during exposure to trans-2-hexenal released from ICs over a seven day storage period at 23°C. (-●-) Growth rate of the same fungi without exposure to trans-2-hexenal over a seven day storage period at 23°C (controls). (-Δ-) Inhibition of the growth of the same fungi after those being transferred to trans-2-hexenal-free atmosphere bioassay systems in new media over a seven day storage period at 23°C. (-▲-) Growth rate of the controls after those being transferred to an trans-2-hexenal-free atmosphere bioassay systems in new media over a seven day storage period at 23°C. Right: (-Δ-) Concentration of trans-2-hexenal released from ICs over a seven day storage period at 23°C.

*Joo, Merkel, Auras, Almenar.*
KEY TAKEAWAYS
• The reasons why the food packaging landscape is changing.
• The principles and types of two growing innovative packaging technologies: active packaging and intelligent packaging.
• How novel packaging can extend the shelf life of baked goods.
THANK YOU

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Our mission:

The mission of the School of Packaging at Michigan State University is to educate packaging professionals and to create innovative solutions that enhance or maintain product quality, increase efficiency and reduce waste. In doing so, we contribute to the economic development and quality of life of citizens within the State of Michigan and across the world through highly relevant educational experiences and cutting edge research. Earn a certificate, bachelors, masters, and PhD from the School of Packaging.

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E-COMMERCE FOOD PACKAGING MARKET STUDY
Dr. Eva Almenar’s Research Group

GOAL
To collect beneficial information that industry can use to improve packaging for E-Commerce

HOW?
• Summarize current packaging materials used to sell food products in e-commerce
• Document the impact of e-commerce on traditional packaging materials and designs
• Quantify specific problems that current packaging faces during online delivery
• Identify changes needed in materials and design to overcome these problems

IF INTERESTED PLEASE CONTACT
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By 2022 consumers predicted to spend $100 Billion a year on online grocery
By Percent of Total U.S. Food and Beverage Sales
School-Industry Collaboration Activities:

Testing Services (Lab manager: Aaron Walworth; (517) 353-4439)
Research projects (info on faculty at http://www.canr.msu.edu/packaging/faculty/faculty/)
Consulting, ideation sessions, conferences projects (info on faculty at http://www.canr.msu.edu/packaging/faculty/faculty/)
PKG 485 project – Senior capstone course (Prof. Koning; (517) 432-4441)
Continuing Education Opportunities (short courses and online courses for industry, more info at www.packaging.msu.edu and (517) 353-6797)