



The School of Packaging
MICHIGAN STATE UNIVERSITY



BAKINGTECH 2018

SUSTAINABILITY-SUCCESS THROUGH PEOPLE

PRODUCTS AND PRODUCTIVITY

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



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PACKAGING TRENDS & NEXT PACKAGING GENERATION



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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



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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.



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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>



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PACKAGING TRENDS

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



http://www.beveragedaily.com/Processing-Packaging/StackTek-innovates-wine-packaging-with-portable-single-serve-solution?utm_source=newsletter_daily&utm_medium=email&utm_campaign=10-Jan-2017&c=MU%2FFM8HGRWPfoFOM0iMvMw%3D%3D&p2=



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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

The flexible packaging market is poised to improve steadily in 2016 as the leading countries continue to drive growth.

February 1, 2016

FLEXIBLE PACKAGING (FEB 2016)

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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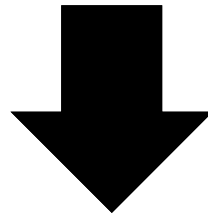


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PACKAGING TRENDS

- 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. ealmenar@msu.edu



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PACKAGING TRENDS

- Personalized packaging



<http://www.packagingdigest.com/labels/coca-cola-launches-biggest-ever-personalized-packaging-campaign-across-europe>



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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, MI, editors. Controlled and Modified Atmosphere Use for Fresh and Fresh-cut Produce. Elsevier (*In press*)).
- Types:
 - Tracking devices
 - Sensors
 - Indicators
 - etc.



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PACKAGING TRENDS

- Packaging that communicates: intelligent packaging



<http://www.brandpackaging.com/articles/85531-new-label-by-avery-dennison-monitors-product-temperature>



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PACKAGING TRENDS

- Packaging that communicates: intelligent packaging



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



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PACKAGING TRENDS

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

• **TODAY'S MAIN TOPIC: ACTIVE PACKAGING**



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NEXT PACKAGING GENERATION

- Packaging changes resulting from current market changes:
 - Clean label
 - E-commerce
 - 3D printing



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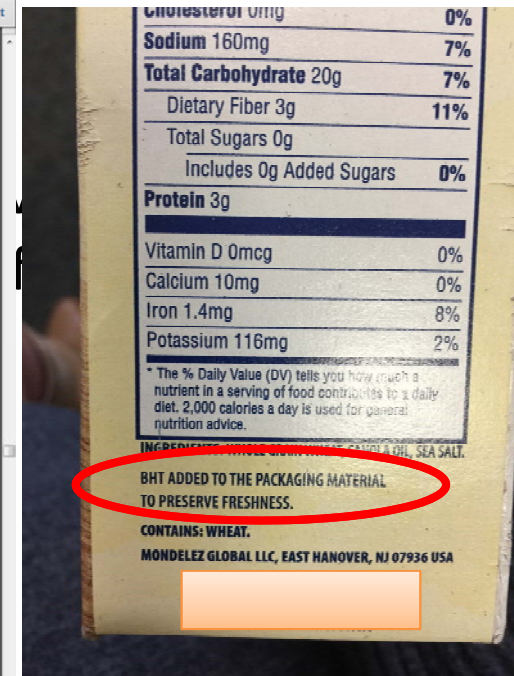
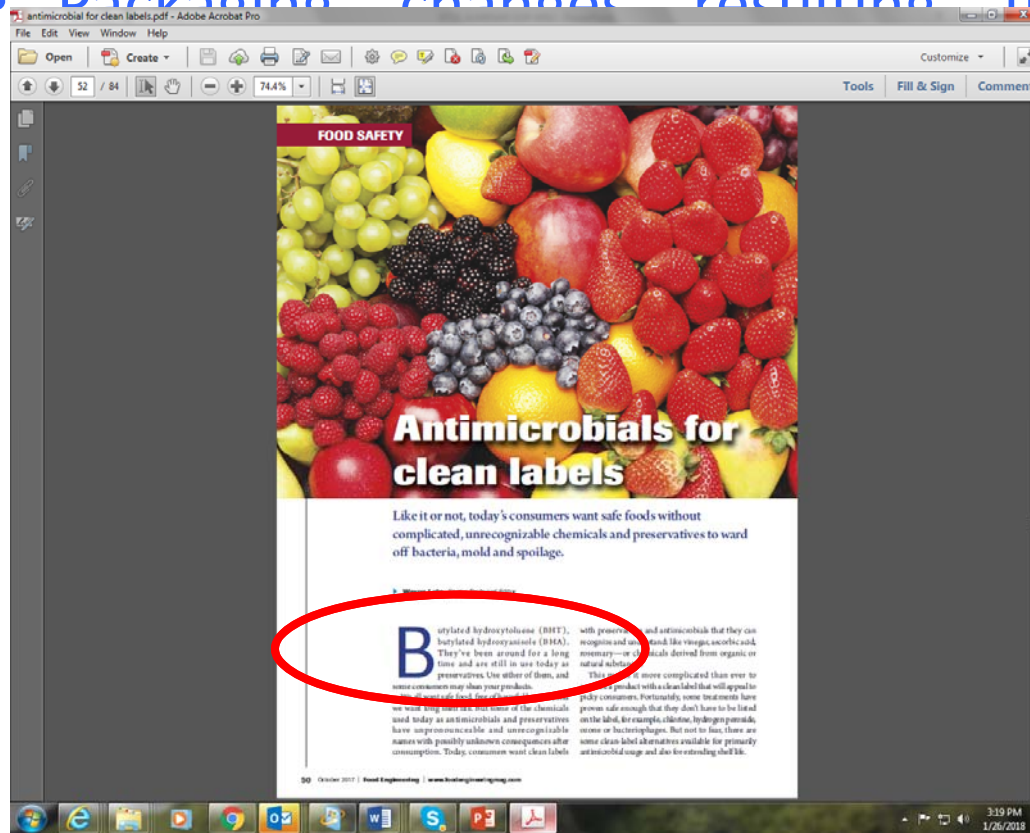
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NEXT PACKAGING GENERATION

- Packaging changes resulting from current market



new
and

<https://www.foodengineeringmag.com/articles/97005-antimicrobials-for-clean-labels?v=preview>



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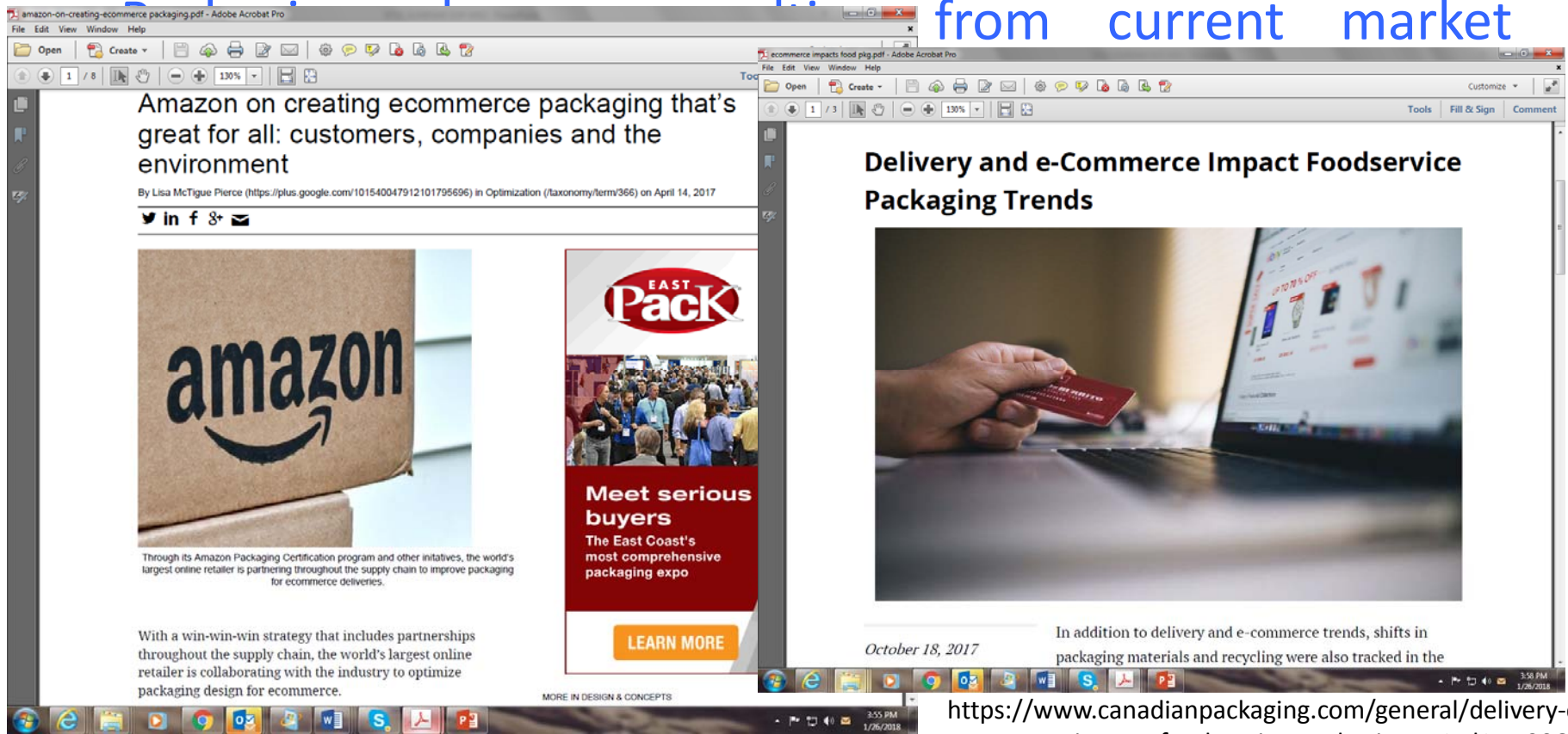
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NEXT PACKAGING GENERATION

from current market



<http://www.packagingdigest.com/optimization/amazon-on-creating-ecommerce-packaging-thats-great-for-customers-companies-and-environment-2017-04-14>

<https://www.canadianpackaging.com/general/delivery-e-commerce-impact-foodservice-packaging-trends-153066/>



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NEXT PACKAGING GENERATION

- Packaging changes resulting from current market changes:

- 3D printing
 - 3D-printing is currently used for production but not for the prod
 - Personalized 3D-printed packag
 - It will take a while for 3D-printing production of flexible packaging (the possible materials still need to be explored and the process is too slow and expensive).



<https://www.brandpackaging.com/articles/86107-the-role-of-3d-printing-in-packaging>



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SPOILAGE OF BAKED GOODS



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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



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SHELF-LIFE EXTENSION OF BAKED GOODS



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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
- Water control



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



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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*)).



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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.)



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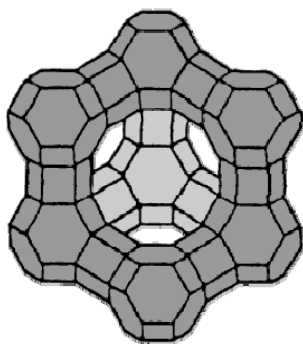
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EXAMPLES OF ACTIVE COMPOUNDS

Highly porous structures

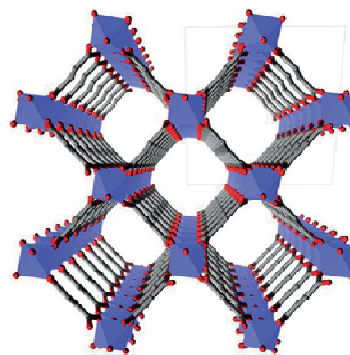


Zeolite 13X

science.uwaterloo.ca

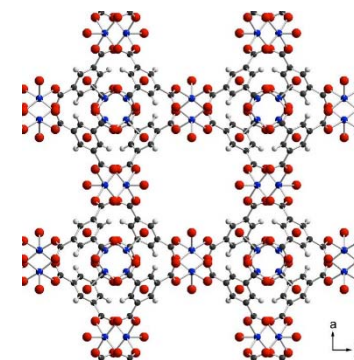


Activated charcoal



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

Cu blue, O red, C gray, hydrogen white. Dawson et al. 2013. Phys. Chem. Chem. Phys. 15, 919–929.



Almenar, E. 2015. Extending the shelf life of food using active packaging based on water regulation— A case study”. 2015 IFT Food Packaging Symposium (Oral communication). February 26, 2018

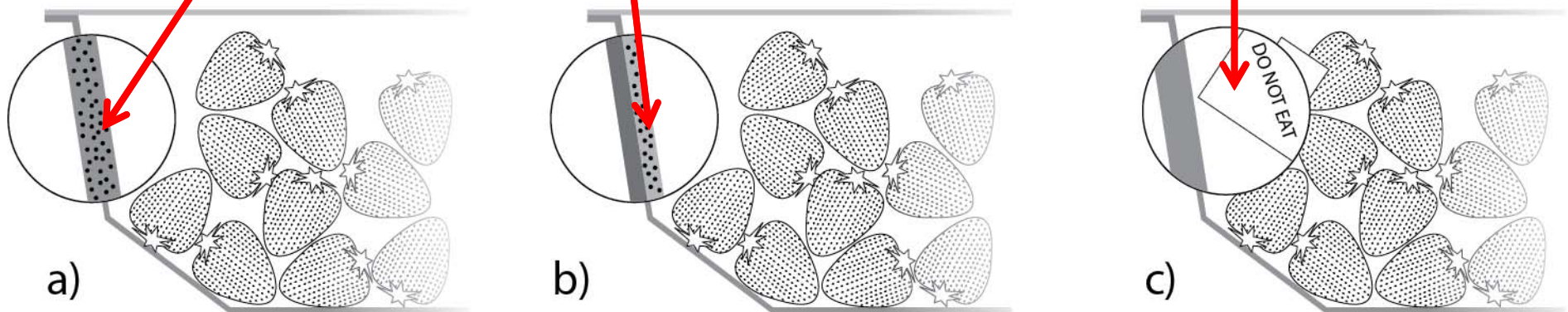
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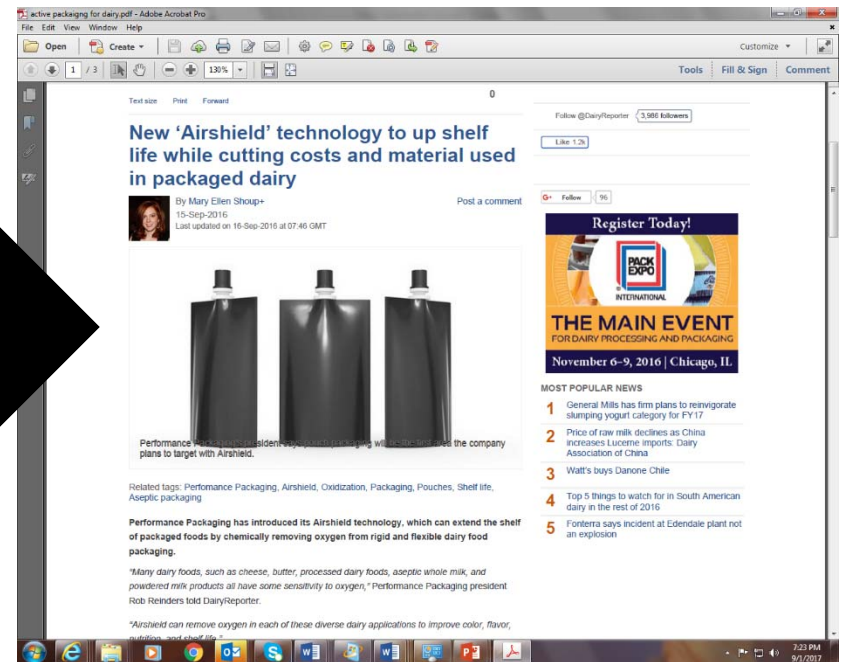
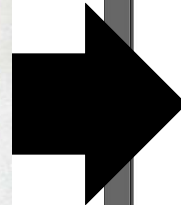
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ACTIVE COMPOUND LOCATION

- 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-SCAVENGING PACKAGING



<http://www.dairyreporter.com/Processing-Packaging/New-Airshield-technology-to-up-shelf-life-of-packaged-dairy>



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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



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OXYGEN-SCAVENGING PACKAGING

- DEFINITION:

- Type of active packaging with the capability of scavenging O_2 to obtain optimal O_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_2 scavenging capability of the active compound with the packaging material permeability and the food characteristics to control in-package O_2 levels.



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OXYGEN-SCAVENGING 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.



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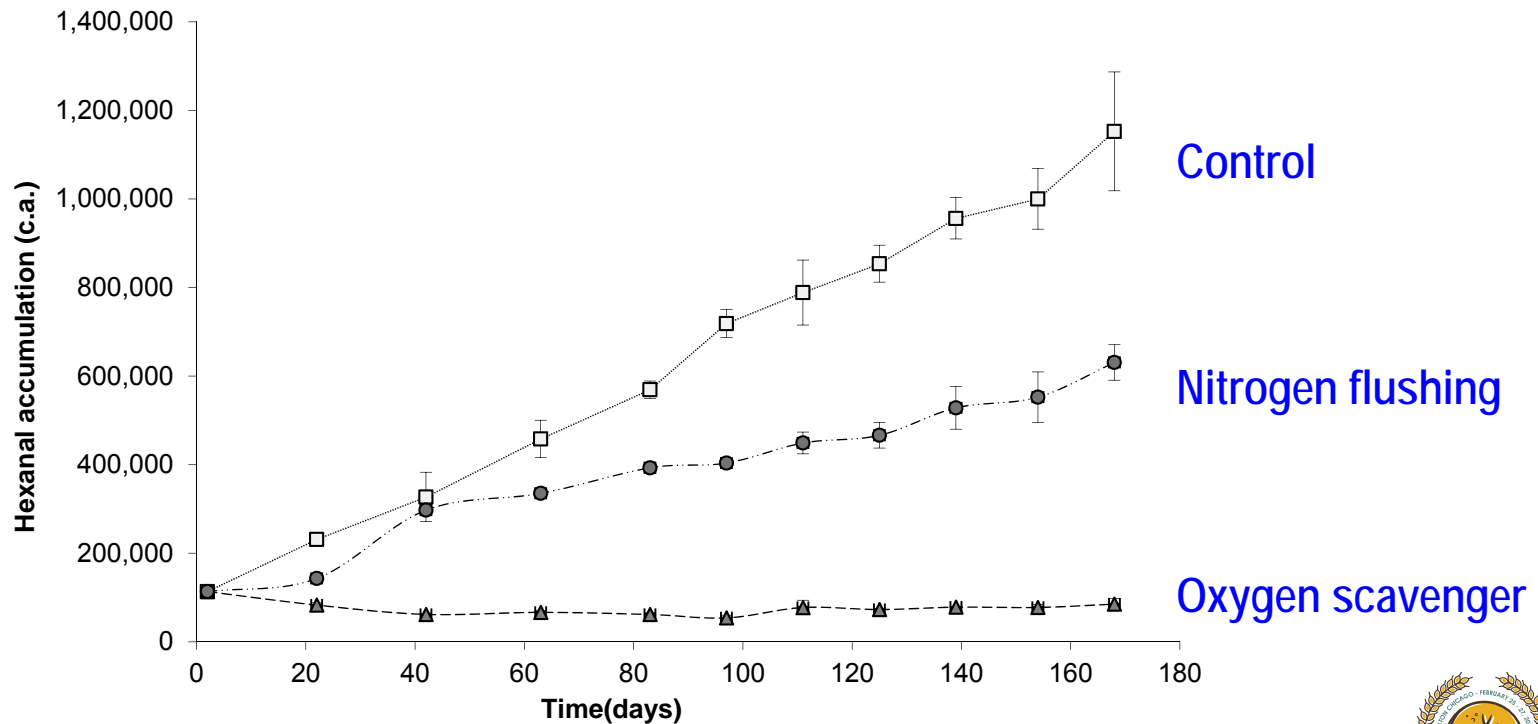
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OXYGEN-SCAVENGING PACKAGING

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).



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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.



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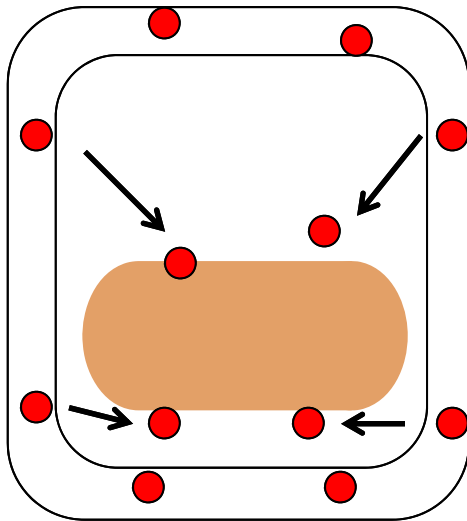
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ANTIMICROBIAL PACKAGING

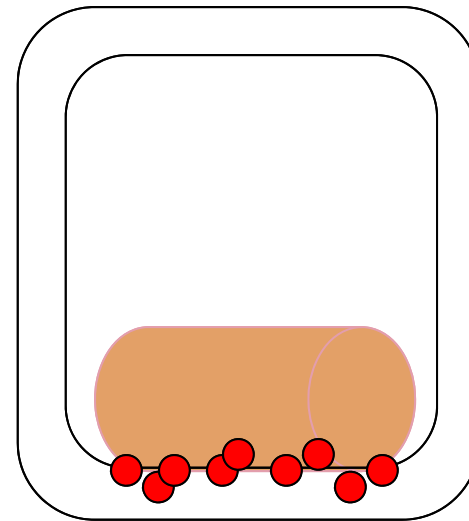
- MECHANISMS OF ACTION:



DIFFUSION

+

EVAPORATION



DIFFUSION



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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)



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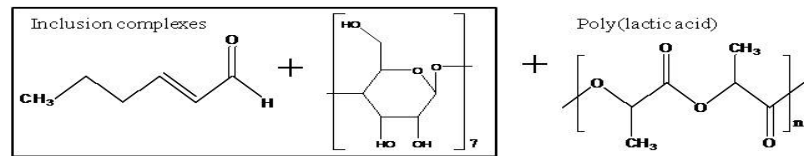


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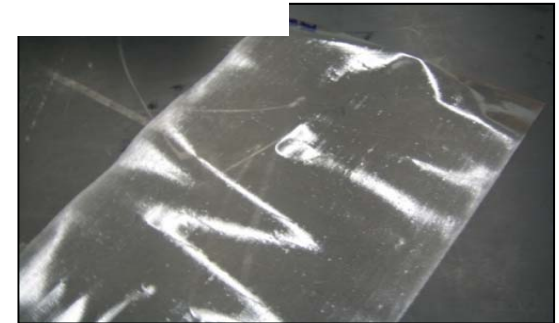
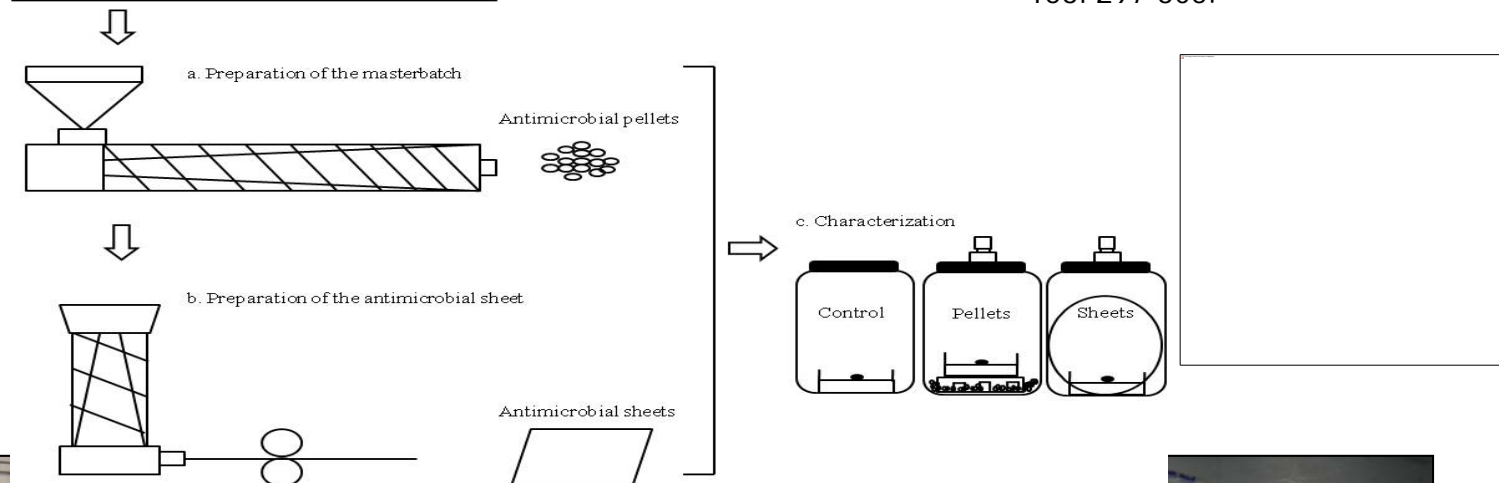


Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs)

- Mechanism de action: **DIFFUSION + EVAPORATION**



Joo, Merkel, Auras, Almenar.
International Journal of Food Microbiology,
153: 297-305.



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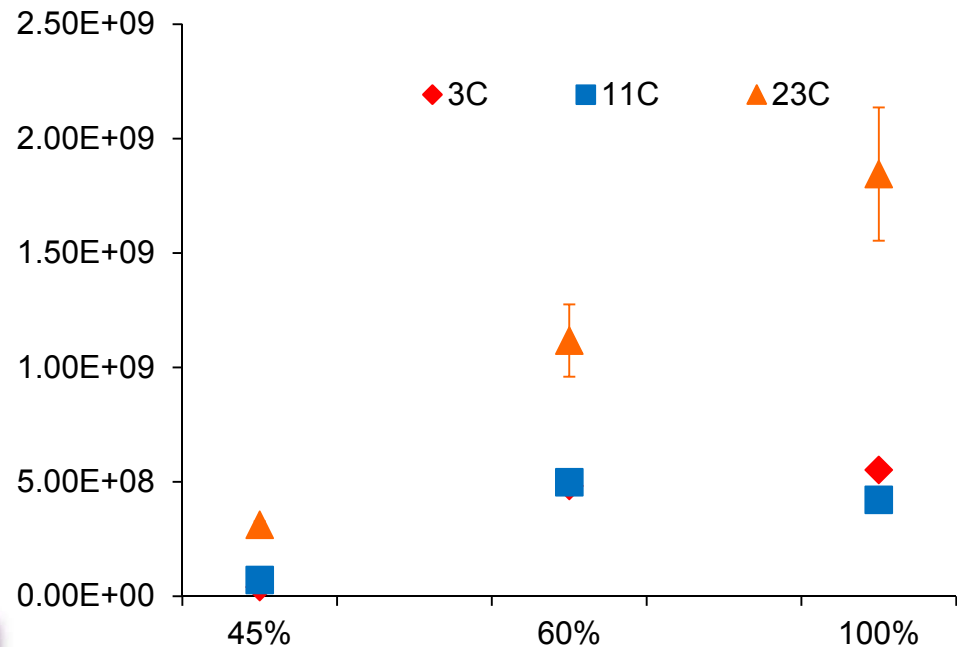
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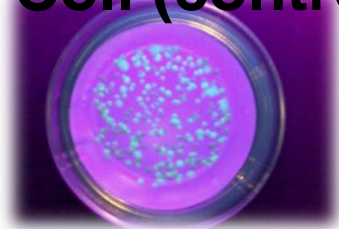
Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs)

- Mechanism de action: **DIFFUSION + EVAPORATION**

Merkel, C.; Joo, M.; Rai, D.; Ryser, E.; Almenar, E. 2011. The kinetics of trans-2-hexenal release from an antimicrobial bio-based polymer matrix made of poly(L-lactic acid). Proceedings of the 25th IAPRI Symposium on Packaging (IAPRI 2011). Berlin, Germany (Oral).



E. Coli (control) **E. Coli (ICs)**



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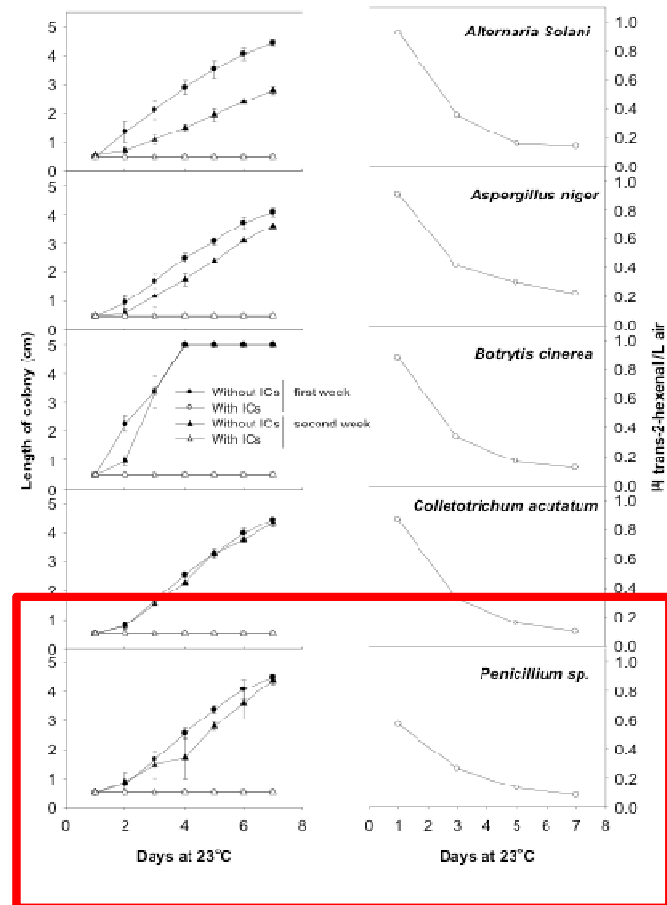


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Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs)

- 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.

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KEY TAKEAWAYS



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- 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.



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THANK YOU



by Gartner

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SPARTANS WILL.

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Michigan State University

www.packaging.msu.edu
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February 26, 2018

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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



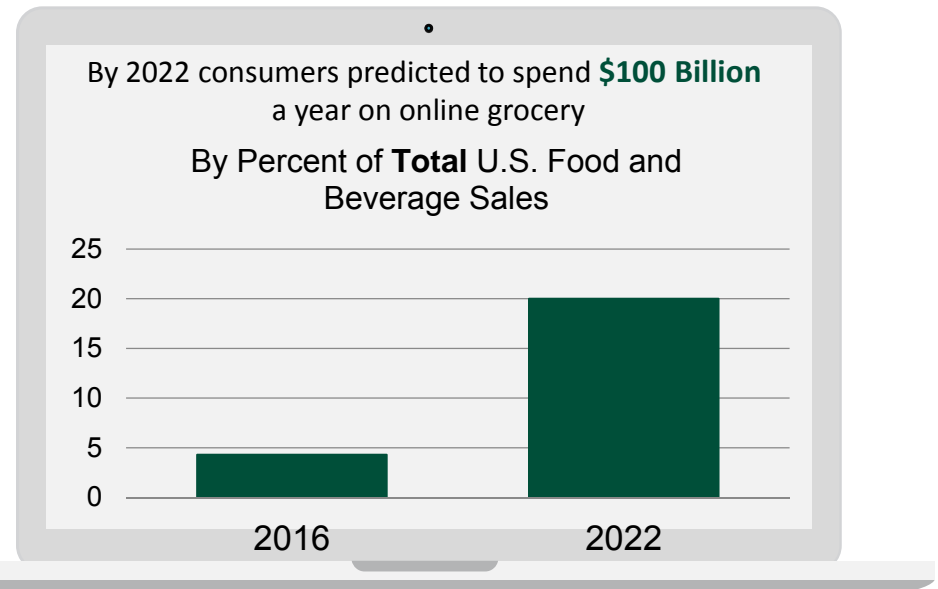
GOAL

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



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IF INTERESETED PLEASE CONTACT
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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)



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