by Katie Clay Sabatini, RD, LDN

EDGE® Express

Advanced Food Packaging

Not a Galaxy Away...Right in Your Refrigerator

FOOD PROTECTION CONNECTION

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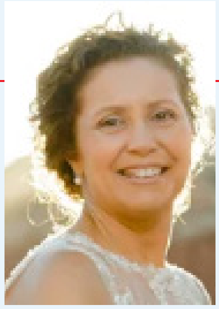
Imagine standing in the aisle of your local grocery store and the packaging of your favorite breakfast cereal begins talking to you, telling you about the health benefits of the product and marketing its safety, freshness, and quality. Does this sound like an episode of the Jetsons to you? Believe it or not, technology like this may not be a galaxy away—in fact you probably already purchase products with advanced packaging and you may not even know it!

The food packaging industry is one of the most dynamic, competitive, and developing markets within the economy today. With a desire to become more functional and innovative, the passive protective barrier functions that packaging was originally designed for are no longer the only goals. Consumers want increased product information, traceability, and innovation. Active packaging (AP) and intelligent packaging (IP) can provide this and more. AP and IP are the wave of the future—the wave of *now*!

TRADITIONAL FOOD PACKAGING

Traditional food packaging was designed to provide the four primary functions of protection, communication, convenience, and containment.

Continued on page 2



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Continued from page 1

1) Packaging *protects* the food product inside from environmental contamination and influences.

2) Packaging *communicates* ingredients, nutritional facts, and marketing—which are all displayed on the exterior.

3) Packaging provides *convenience* for the consumer such as dispensing and resealing features, ease of handling, product visibility, and uniqueness as well as extra features, like the ability to cook and eat the product within its specific packaging.

4) Packaging offers cost-effective *containment* during transportation and storage that maintains food safety and minimizes environmental impact, while complying with industry requirements and meeting consumer demands.

Traditional packaging materials include glass, metals, paper/paperboards, and plastics, each being used for different reasons with unique specifications regarding the packaging material and the product inside. Over time, manufacturers have combined these materials to provide the best functional, aesthetic, and/or consumer-driven attributes and properties for the food item inside. An example of combination packaging would be high density polyethylene (a common type of plastic used in food packaging materials) liners in cardboard cereal boxes.

Food packaging has historically been designed to be as inert as possible, minimizing the interaction of food product with its protective outer barrier. However, AP is unique in that it utilizes the reaction of said food product with its packaging material or the environment to create a beneficial effect for the product and end user. AP allows the food inside and the environment outside to play off of each other (in a controlled fashion) to dynamically preserve or protect the food inside. AP systems are innovations in the food industry and work through the processes of absorption or release of various gases, moisture, or other substances into the packaged environment. The goal of AP is to have absolutely no effect on or transfer to the food item. Rather, the desired outcome of this process is improved conditions inside the packaged environment to prolong shelf life, improve microbiological safety, positively affect sensory properties, and maintain food quality.

TYPES AND APPLICATIONS OF COMMERCIAL ACTIVE PACKAGING (AP)

Oxygen Scavengers

Oxygen results in the deterioration of the packaged end product through oxidation, rancidity, and microbial growth—to name a few. Therefore, a method to reduce or eliminate oxygen within the packaging atmosphere is very desirable and can be accomplished with oxygen scavengers that either expunge or absorb oxygen. The most common oxygen scavenger works through the oxidation of iron compounds placed in sachets within the package that absorb oxygen. Additionally, certain iron compounds are being embedded in plastic polymers to perform the same function, but reduce the need for a foreign object (sachet) to be placed inside the package. Some of the products on the market using oxygen scavengers are baked goods, pizza, pasta, cured meats, cheeses, fish, coffee, snack foods, dried foods, oils and fats, and beverages.

Continued on page 3

Continued from page 2

Carbon Dioxide Emitters

Carbon dioxide (CO_2) has innate antimicrobial properties. CO_2 emitters actively produce and release this gas within the package to inhibit spoilage and control harmful microorganisms, preserving food quality. CO_2 emitters are often found in products like coffee, snack foods, nuts, bakery items, dried and fresh meats, and fish. Additionally, bifunctional AP systems are often used which include oxygen scavengers working in tandem with CO_2 emitters, whereby as oxygen is absorbed, it is replaced by CO_2, optimizing the atmospheric conditions within the package.

Ethylene Scavengers

Ethylene is a phytohormone which accelerates produce ripening and results in spoilage of the packaged product if not properly controlled. Ethylene scavengers are used to control the ripening process in packaged fruits and vegetables by absorbing ethylene from the packaged environment, preventing deterioration and increasing shelf life. The most common ethylene scavenger is potassium permanganate embedded in silica gel sachets. Another option on the market is the addition of ethylene absorbers to zeolite clay, which is then embedded into food-grade films used in packaging materials for fruits and vegetables.

Odor Emitters and Absorbers

Also known as "Artificial Nose," odor emitters produce scent within packaging that enhances palatability to consumers like a ripe fruit scent, while odor absorbers cover unpleasant off-odors produced by certain packaged items (also referred to as odor stabilizers). Odor emitters and absorbers are most often incorporated into plastic packaging through additives embedded into the polymers.

Moisture Scavengers

Humidity management within food packaging is essential to a high quality end product. Moisture scavengers reduce water activity, thereby inhibiting spoilage microorganisms from negatively effecting the food inside. There are two types of moisture scavengers. *Liquid absorbers* usually come in the form of pads or sheets that have a hygroscopic layer that absorbs and holds moisture and are often used in high water activity items like meat, poultry, fish, and produce. *Relative humidity regulators*, commonly referred to as desiccants, absorb moisture and control humidity in the headspace of the package in the form of sachets or labels that are often used in foods with lower water activity like snack foods, cereals, nuts, and spices.

Antimicrobial Emitters

Antimicrobial (also called antibacterial) packaging is based on the ability to slow or inhibit microbial growth on the food item to extend shelf life and prevent dangerous spoilage. Antimicrobial emitters can be found as sachets (the most common form on the market) or mats; embedded in packaging polymers or bonded to the polymers during embossing; or in packaging films. This technology is not as widely accepted or utilized as the aforementioned methods, due to strict regulations surrounding the use of antimicrobial substances for human consumption, as well as relatively low consumer acceptance due to the high cost of this packaging technology. One of the more common commercially available antimicrobial packaging options that you may already be familiar with is Microban®, which uses silver in zeolite clay to control Gram-positive and Gram-negative bacteria growth. Microban® is used in a lot more than just food packaging materials, including some cutting boards, manufacturing equipment and food grade sanitizing options, as well as many other applications across the food industry.

AN OVERVIEW OF INTELLIGENT PACKAGING (IP)

IP actually monitors the food and/or environment inside the package and communicates information regarding

Continued on page 4

SEE PAGE 5 FOR CE QUESTIONS

Continued from page 3

food quality, whether that be to the end consumer or anywhere throughout the flow of food in the supply chain. It is functional, in that it records, detects, senses, traces, and communicates information about the food product to extend shelf-life, improve quality, and identify any safety concerns. The three types of IP are: sensors, indicators, and data carriers.

Sensors

The sensing part of a sensor is often referred to as the receptor and is capable of quantitative measurement, whether that be activity, concentration, composition, etc. The receptor sends its data signal out to a transducer which measures the result. Transducers can be either passive (do not require external power for measurement capabilities) or active (they do require power).

Indicators

Indicators can only provide qualitative information about the food inside the package, most commonly in the form of an irreversible color change that provides data to the consumer. Different types of indicators include: gas indicators, freshness indicators, and time temperature indicators (TTI), all providing information about the quality and safety of the food within the package. You are probably most familiar with TTIs, as many food manufacturers and distributors are including these on the boxes or inner packaging of refrigerated and frozen products to track mishandling and temperature abuse through the supply chain.

Data Carriers

The most common and simplest type of data carrier is a bar code, which has been used on packaging for decades. Barcodes are still used for identification, but have progressed to QR codes and the more advanced radio frequency identification (RFID). RFID tags have a microchip attached to an antenna and communicate through electromagnetic waves. RFIDs can be passive (no battery, powered by electromagnetic waves emitted by the reader); semi-passive (use a battery to emit electromagnetic waves or store information); or active (powered by an internal battery to run internal data management and broadcast it to a reader).

Originally designed as tracking devices used for identification, traceability, counterfeit protection, and warehouse automatization, RFIDs have advanced tremendously and progressive technology combining sensors with RFID technology are resulting in state-of-the-art monitoring capabilities allowing food quality to be recorded and communicated throughout the supply chain. This ensures freshness, quality, and safety of the foods we receive and serve every day.

SUMMING IT UP

Food packaging will always need to provide the essential functions for which it was originally designed. However, with technological breakthroughs occurring almost daily, AP and IP are becoming mainstream. IP and AP are not mutually exclusive. In fact, by combining the existing technologies of each system, a new and exciting field of Smart Packaging has emerged which can provide a complete solution to the food industry by monitoring both the product and its environment, then acting upon these results for a safer and more efficient supply chain from farm to fork. Smart packaging can also be a very valuable tool in food safety risk management, including benefits to Hazard Analysis Critical Control Points (HACCP) and Quality Analysis Critical Control Points (QACCP), not to mention a superior end product for the consumer. Manufacturers are realizing that the use of AP, IP, and Smart Packaging offer them a real market advantage. As the technology behind these packaging techniques continues to advance quickly, simultaneously driving costs down, what once seemed out of the realm of possibility—almost like science fiction—will become a standard practice in the food industry globally within our lifetime, resulting in safer and higher quality foods.

REFERENCES

- Biji, K. B., Ravishankar, C. N., Mohan, C. O., & Srinivasa Gopal, T. K. (2015). Smart packaging systems for food applications: A review. Journal of Food Science and Technology, 52(10), 6125-6135. doi:10.1007/s13197-015-1766-7
- Brody, A. L., Bugusu, B., Han, J. H., Sand, C. K., & McHugh, T. H. (2008). Innovative food packaging solutions. Journal of Food Science, 73(8), R107-R116
- Dainelli, D., Gontard, N., Spyropoulos, D., Zondervan-van den Beuken, E., & Tobback, P. (2008). Active and intelligent food packaging: Legal aspects and safety concerns. Trends in Food Science & Technology, 19, S103-S112. doi:10.1016/j.tifs.2008.09.011
- Lee, S. Y., Lee, S. J., Choi, D. S., & Hur, S. J. (2015). Current topics in active and intelligent food packaging for preservation of fresh foods. Journal of the Science of Food and Agriculture, 95(14), 2799-2810. doi:10.1002/jsfa.7218
- Marsh, K., & Bugusu, B. (2007). Food Packaging—Roles, materials, and environmental issues. Journal of Food Science, 72(3), R39-R55. doi:10.1111/j.1750-3841.2007.00301.x
- Muhammad Sohail, Da-Wen Sun & Zhiwei Zhu (2018) Recent developments in intelligent packaging for enhancing food quality and safety, Critical Reviews in Food Science and Nutrition, 58:15, 2650-2662, doi:10.1080/10408398.2018.1449731
- Müller, P., & Schmid, M. (2019). Intelligent packaging in the food sector: A brief overview. Foods (Basel, Switzerland), 8(1), 16. doi:10.3390/foods8010016
- Theeranun Janjarasskul & Panuwat Suppakul (2018) Active and intelligent packaging: The indication of quality and safety, Critical Reviews in Food Science and Nutrition, 58:5, 808-831, doi:10.1080/10408398.2016.1225278
- Vanderroost, M., Ragaert, P., Devlieghere, F., & De Meulenaer, B. (2014). Intelligent food packaging: The next generation. Trends in Food Science & Technology, 39(1), 47-62. doi:10.1016/j.tifs.2014.06.009
- Wyrwa, J., & Barska, A. (2017). Innovations in the food packaging market: Active packaging. European Food Research and Technology, 243(10), 1681-1692. doi:10.1007/s00217-017-2878-2

CE Questions: Food Protection Connection

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II *This Level II article assumes that the reader has a foundation of basic concepts of the topic. The desired outcome is to enhance knowledge and facilitate application of knowledge to practice.*

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1. Which is not a traditional packaging material?
   A. Plastic
   B. Glass
   C. Ceramic
2. Active packaging is designed to be as inert as possible.
   A. True
   B. False
3. The goal of active packaging is to transfer the packaging additive to the food item and make organoleptic changes to the product.
   A. True
   B. False
4. Which of the following are types of active packaging?
   A. Oxygen scavengers and carbon dioxide emitters
   B. Sensors and oxygen scavengers
   C. Carbon dioxide emitters and RFID
5. Bifunctional active packaging systems include which two active packaging methodologies working together to improve food quality?
   A. Oxygen scavengers and ethylene scavengers
   B. Oxygen scavengers and CO2 emitters
   C. Oxygen scavengers and moisture absorbers
6. Intelligent packaging allows the food inside and the environment outside to dynamically interact to preserve and protect the food.
   A. True
   B. False
7. The three types of intelligent packaging are:
   A. Sensor, indicator, emitter
   B. Scavenger, absorber, sensor
   C. Sensor, indicator, data carrier