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Packaging to Limit Microbiological Concerns

Inconveniently squeezed into a late Friday afternoon slot on the Food Marketing Institute's 2001 Supermarket Food Safety Conference last month in New Orleans was a one-hour session dubbed by the organizers, "Packaging: in Search of the Next Dimension." The original intent was to portray packaging and its new technologies as complementary protectors of food against mainstream microbial spoilage and pathogens. Discussions of *Listeria,* ionizing radiation, federal regulation, tracing for recalls, safety of organic foods, and the effects of e-commerce were scheduled to precede the climactic final barrier, packaging.

But then came the late-breaking bioterrorism and discussions of its more conventional cousins, normal pathogenic flora naturally in—and a very few potentially intentionally added to—foods eaten uncooked. Instantly, FMI and its grocery retailer members found themselves faced with a littany of headline events that confused and confounded, and in a higher position in the hierarchy of topics for open debate on the conference program. Food packaging as an aid to protecting the food was relegated to a sort of corollary position on the program.

Regardless, the intriguing topic of food packaging to protect against microbiological insult had been addressed in a Packaging Machinery Manufacturers Institute program on "Packaging Solutions" late last year. During her introduction to that program, Barbara Blakistone said that food microbiologists want controlled (in-package) microenvironments in which competitive microflora eliminate opportunities for pathogenic microbiological growth. Traditionally, we view packaging as a physical barrier against contamination or recontamination of contained food. With the development of minimally processed foods, we must establish further obstacles, because microorganisms, possibly including some pathogens, are present and capable of spoiling food and even possibly causing health problems under the right circumstances as the foods pass through our country's deficient distribution system.

Thus was born hurdle technology—combining growth-inhibiting factors at subinhibitory levels from several different counter-microbial-growth entities in synergy to delay or sometimes even prevent microbiological spoilage or adverse public health events. Among these antiproliferation entities are pH, water activity, thermal pasteurization, salt, sugar, and packaging such as reduced oxygen. And then came holistic hurdles—the careful quantitative integration of all known variables to delay and even prohibit microbiological problems. Incorporated into some thinking was the notion that the deliberate presence of spoilage microorganisms would compete effectively against pathogenic microbial growth, and safe foods could result. This "technology" functions effectively throughout primal-cut-meat barrier packaging under vacuum and in fresh-cut vegetables with their reduced-oxygen packaging.

Reduced-oxygen packaging has benefits for both fully and minimally processed foods when oxygen is removed from the package interior and the package structure is a good oxygen barrier, as with cured meats, wet pasta, some pasta sauces, and now some soups. In conventional modified-atmosphere packaging (MAP), reduced oxygen is generally combined with elevated carbon dioxide to take advantage of the suppression of Gram-positive microbiological growth. MAP is used extensively in the packaging of home-meal-replacement foods, cured and fresh cheeses, case-ready fresh red meats, and a host of other foods. But MAP is *not* a panacea against pathogenic microbiological growth, spoilage microorganisms, poor initial microbiological quality, or mediocre refrigeration during distribution. With fresh and minimally processed foods, good microbiological practices, proper chilled temperatures during distribution, and gas-barrier packaging are essential to achieve the safe shelf-life objectives regardless of what they are, and generally they are limited to measures of days or weeks under the best of circumstances. And the lower the temperature above freezing the better!

Food packaging per se is not the route to microbiological safety. It should be axiomatic that the contained product and its distribution and processing are equally or more important to the preservation of the food. If all other variables are constant, the package maintains or enhances the protective effects of the other elements. While all the other components are comprehended and incorporated, the role of packaging can be quantitatively involved. Simplistically citing oxygen permeability of a plastic package material as a measure of oxygen barrier that will maintain a specific internal microenvironment is omitting a massive overlay of other influencing variables, some of which have already been hinted at: removing oxygen from the product, eliminating oxygen from the package interior, effecting a reliable hermetic seal on an efficient machine, ensuring that the rigors of distribution do not disrupt the package or closure integrity and foster entry of air, etc. And oxygen barrier of a package material does not necessarily mean that the package is a good moisture barrier, as those who employ ethylene vinyl alcohol as an oxygen barrier in their package structures will attest.

If the moisture is not controlled initially and through effective passive packaging, then the small amount of residual oxygen inevitably remaining can accelerate oxidative reactions, not the least of which could be aerobic microbiological growth. And should you care to opt for so-called infinite-barrier packages such as metal or glass, our recent learnings have indicated that closures, seams, and finishes do permit finite quantities of air to enter to upset the internal microenvironment and to allow microbiological growth if, by chance, any remain. This microleak situation, of course, has been demonstrated to be more consequential for biochemical food deteriorations than for microbiological. But, beware, because measurable microbiological microleaks can and do occur with all types of so-called hermetically sealed packages and must be accounted for.

Departing from the realm of conventional mainstream passive packaging heralded for its protective attributes, we turn our attention to the wonderful new dimensions that will represent a future of food packaging.

• Active packaging, which has been discussed in this column in isolation, is not quite ready for prime time, despite its many applications. When we elect to remove residual and entering oxygen, scavengers function effectively—sometimes even too effectively, generating negative pressure within the package and causing undesirable partial-pressure driving forces.

• Control of Gas Permeation. Responsive controlled-gas-permeability package materials such as Landec *Intellipac,* originally targeted at increasing oxygen permeability to avoid anoxia in packages of respiring produce, can also ameliorate flow of carbon dioxide and thus enhance the microbistatic effects of this gas.

• Antimicrobial Packaging. Antimicrobial packaging incorporates compounds such as silver salts, bacteriocins, chiotosan, ethanol, allylisothiocyanate, or precursors of chlorine dioxide to act against microorganisms on or, in some cases, just beneath the surfaces of contained food. Although many function in vitro, the actions may not be as easily translated from laboratory bench to commercial practice. At least one proposed system involves surface treatment of package materials with fluorine-based plasma, resulting perhaps in self-sterilizing or -pasteurizing package structures.

Whatever the outputs today—admittedly meager—in the future, package materials active in control of microorganisms are possible.

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Tomorrow, as we face the challenges of microorganisms adapting to our preservation techniques, and as we try to cope with the dichotomy of minimizing processing to satisfy consumers' desire for better quality, we must identify new challenges for the microorganisms to overcome. Microorganisms are quite capable of evolving into forms that have in the past, and certainly will in the future, lead to singular food safety issues. We have only *Escherichia coli* O157:H7 as an example of a recently emergent issue. Ensuring microbiological food safety demands consideration of the risks in all phases of food processing and distribution, including packaging and consumer handling.

No one can guarantee microbiological food safety, but as we probe deeper into minimal processes to better retain initial quality food product (thus reducing our bludgeon approach to microbial elimination), we must regard packaging as a potential activist in controlling what remains. This is certainly not the total answer, since, by definition, packaging is an inherent element—one of many that we employ in our new holistic hurdle-technologies approach. We cannot view packaging as some sort of final defense to the delivery of safe food. Nor is packaging a mechanism that will magically erase either intentional or incidental contaminations.

But when judiciously employed, packaging plays a critical role as we move away from post-fill-sterilized canned foods and from frozen foods. And the more we involve packaging in its more active forms, as we learn them, the better we shall be able to meet the always-increasing challenges of microbiological food safety. It is fascinating that as we strive to fulfill the eternal goal of offering fresh quality foods to consumers, the barriers erected by the forces of food spoilage seem to grow larger and more complex! It might be that our ancestors were correct in their old adage that the more we learn, the more we realize how little we really know.

PRODUCTS & LITERATURE

Packaging Films for produce, frozen food, and other package converting applications feature clarity, sealability, and high oxygen transmission rates (300–400 cc/24 hr/in^2/mil at 90% relative humidity). AP2042 is a low-density-polyethylene film with commercial clarity, good puncture resistance, and very good stiffness and strength, and AP2050 is a combination of LDPE and plastomer that features higher clarity, strength, and puncture resistance and a broader sealing range. For more information, contact Atlantis Plastic Films, Inc., Custom Films Div., 1870 The Exchange, Suite 200, Atlanta, GA 30339 (phone 770-988-1666, fax 770-618-7080, www.customfilm. com).

Ink Jet Printer is designed for use in environments with high levels of dust, vapor, or sugar, such as soft drink and food manufacturing plants. The printer's stainless-steel cabinet features a unique pressurization system that protects it from airborne contaminants, and automatic sensors ensure that the unit operates properly. For more information, contact Domino Amjet Inc., 1290 Lakeside Dr., Gurnee, IL 60031 (phone 847-244-2501, fax 847-267-2645).

Thermoformable Film made of a polyolefin blend is suitable for use in frozen food applications, including poultry, meat, seafood, bakery, pizza, vegetables, fruits, and bakery goods. The Flexform™ B web is said to be extremely tough and puncture resistant and can be run on most form/fill/seal equipment. For more information, contact Rollprint Packaging Products, Inc., 320 Stewart Ave., Addison, IL 60101 (phone 630-628-1700, fax 630-628-8510). ●