FOOD PRODUCT DESIGN

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Natural Food Protection

By Renée Gan, Contributing Editor

It is no secret that consumers today are looking for natural ingredients on their food labels—or perhaps more accurately, the absence of chemical-sounding ones. The natural arena is heating up, buoyed by the growing popularity of the locavore and sustainability movements. In a recent release from the Natural Marketing Institute (NMI), Harleysville, PA, “pure and simple” was listed as one of the top trends for the new decade, with “cleaner labeling” and “less is more” specifically cited. This puts the onus on food scientists to develop products without the old stand-by preservative systems.

Tying up free radicals

Oxidation—particularly of fats—can be one of the biggest issues in manufactured foods. Synthetic antioxidants, such as BHA and BHT, are very effective, but not very natural. Therefore, demand for naturally occurring antioxidants is rising.

First, a quick review of the autoxidation reaction: Oxidation occurs when free radicals formed in the initiation step combine with oxygen to form peroxy radicals. These peroxy radicals yield hydroperoxides in the propagation phase.

Antioxidants act by either inhibiting the formation of free radicals in the initiation phase or hindering the free-radical chain reaction in the propagation phase. The majority of the antioxidants in food act as free-radical scavengers, thereby terminating the chain propagation reaction. In addition, synergists scavenge free radicals along with the primary antioxidant, or metal chelators inhibit the formation of free radicals in the initiation step.

A natural against oxidation

Plant-based antioxidants, such as essential oils, tocopherols and extracts, have shown they are able to stand up with the synthetics when it comes to antioxidant and antimicrobial activity. One such example is rosemary extract, which is quickly becoming one of the go-to natural antioxidants because it contains phenolic compounds that can bind free radicals. Commercial applications have shown protective effects similar to that of BHA and BHT. “Specific rosemary extracts can replace synthetic antioxidants in meat applications,” says Jim Bacus, Ph.D., managing partner, Technology Ingredient Solutions LLC, Gainesville, FL. “Carnosic acid is the key indicator for rosemary activity. We evaluated natural pepperoni for 130 days at 36°F, and found that 100 ppm carnosic acid provided the same oxidative inhibition as did a combination of BHA and BHT used at the maximum allowable limit.” Similarly, just 50 ppm carnosic acid was able to protect color stability in fresh pork sausage compared to BHA and BHT.

“Successful applications of rosemary extract have been in the preservation of poultry fat without flavor alteration, and in avoiding warmed-over flavor (WOF) development in precooked meat products,” says Samuel Menard, sales director, Naturex, Inc., South Hackensack, NJ. “After having screened

multiple botanical and spice extracts for almost 20 years, our technical groups have determined that rosemary has proven to be the most efficient and sustainable product with respect to antioxidant power, abundant raw materials and cost-efficiency."

Spicing up the bac attack

A group at USDA's Agricultural Research Service (ARS), Western Regional Research Center (WRRC), Albany, CA, is evaluating the bactericidal properties of various essential oils and active compounds found in plant extracts. They have shown that carvacrol, an essential oil and an active ingredient in oregano, was found to have a bactericidal effect on *E. coli* O157:H7 and *Salmonella enterica*. The method of delivery to administer the essential oils is novel: edible films made with purées of apple or tomato.

In an earlier study, Mendel Friedman, research chemist, ARS WRRC, performed an exhaustive investigation of more than 200 botanicals for antimicrobial activity (*Journal of Food Protection*, 2002; 66(10):1,811-1,821). Some of the front-runners were oregano, thyme, cinnamon, clove, lemongrass and allspice. That work became the backbone for subsequent edible film studies.

In one of those studies, apple-purée films made with carvacol or cinnamaldehyde at different concentrations (0.5%, 1.5% and 3.0%) were wrapped around raw chicken breast and ham inoculated with *S. enterica* and *E. coli* O157:H7 and held at different temperatures. Researchers observed significant log reductions in both pathogens—from 0.7 all the way up to 7.8 log CFU—with carvacrol showing better activity than cinnamaldehyde under certain conditions. This technology shows promise for controlling surface pathogens on meats.

However, such approaches might pose a hurdle or two. When incorporated into films at concentrations needed to kill pathogens, notes Tara McHugh, Ph.D., research leader, ARS WRRC, they could adversely affect the sensory properties of the final foods. "We are working on developing films that are also sensorially acceptable," she says.

The somewhat beleaguered, but popular, bagged-salad category could be dealt some relief from recent food-safety issues by utilizing another dimension of this technology. "We have studied the vapor action of natural antimicrobials, and many of these are active in the vapor phase. For products like leafy greens, we feel this offers potential benefits," says McHugh. This may prove an exciting breakthrough, since the vapor phase could work its way into the crevices of leaves where pathogens are hiding—a real issue with bagged salad greens.

To demonstrate vapor-phase efficacy, tomato-purée films laced with oregano oil (carvacrol), allspice oil (eugenol) and garlic oil (high volatiles, sulfides) were pitted against *E. coli* O157:H7, *S. enterica* and *Listeria monocytogenes*. "These tests were performed in Petri dishes containing bacteria, not on actual spinach," notes McHugh. "However, the results are promising. We are performing tests on produce now, and results will be completed in the near future." Researchers envision squares of the edible films placed in the bag with the lettuce to do their thing. The vapor action could add another much-needed layer of protection for bagged leafy greens.

Natural 'cures'

For natural salami and sausage, alternatives to adding synthetic nitrate are employed. Plant sources like spinach and celery, which have inherently high amounts of nitrate, can be substituted.

"We are trying to find natural ingredients that will contribute to control of bacterial growth, and for those that do, trying to determine how much help they may offer for 'naturally cured' processed meats," says Joseph Sebranek, Ph.D., professor, Iowa State University, Ames.

Sebranek cautions that consumers may expect natural meat products to be able to withstand the same handling and temperature abuse as a conventionally cured product from a microbial standpoint, which is not always the case. "The most-meaningful comparison is the in-going, or added, nitrite or nitrate, because curing reactions reduce the nitrite concentrations in both cases," he says. "This makes the residual nitrite a relatively poor indicator of how much was initially added or generated from nitrate. The added nitrite for sausage products in conventional curing is limited to 156 ppm, and that is what is most often used. The 'natural cure' with celery powder adds the equivalent of 40 to 80 ppm, depending on the form and amount used. So, the concentration is about 25% to 50% of the conventional curing approach."

Natural vinegar, lactate and lemon powder have also shown an ability to fight bacteria. "The effective ingredients help by increasing the lag phase by anywhere from a few to several days, but temperature plays a major role, as you would expect," says Sebranek. "Several of the major meat processors are using high-pressure pasteurization to improve the bacterial control of the naturally cured products, and thus provide the added protection that is achieved in the conventional curing process."

Regarding their research, Sebranek notes that "the general effects that we have seen seem to apply to several pathogens. We have measured responses for *L. monocytogenes* and *Clostridium perfringens*, and have collaborated with another laboratory for work on the same products with *C. botulinum*."

Fermented protection

Bacterial fermentates can also serve as natural preservatives and are growing in popularity along with the natural product category; examples are nisin, natamycin and several cultured products with label-friendly names such as cultured cane or corn sugar, cultured dextrose, and cultured skim milk. When using these antimicrobials, product developers should know what organisms they want to fight: gram-positive or gram-negative bacteria, molds, yeasts or different combinations thereof.

"Natamycin is a surface-active direct antimycotic and, therefore, will prohibit fungi growth by exerting an inhibition area around each particle of natamycin," says Jit Ang, executive vice president, International Fiber Corporation, North Tonawanda, NY. "When enough particles are present, these growth-free areas will be abundant enough that they overlap, thereby preventing yeast and mold growth in the food to which natamycin is applied. Natamycin functions by distorting the cell membrane of fungi, thereby creating 'leaky' membranes."

Certain factors should be taken into account when using natamycin. “Natamycin is most stable around neutral pH,” says Ang. “High and low pHs will reduce its stability. It is not very sensitive to heat, but UV light will degrade natamycin.

“For normal natamycin to work, literature has reported that a minimum of 7 ppm must be present on the surface of cheese or food,” continues Ang. “However, recent innovations have improved upon this, and new forms of patented natamycin have been shown to be significantly more effective. In the United States, food regulations will permit not more than 20 ppm natamycin to be present on the surface of shredded and grated natural cheeses. In Canada, the permitted level is 10 ppm. Normally, natamycin is more effective against mold, and higher concentrations may be required for yeast inhibition.”

Cultured-sugar preservation products provide a broad spectrum of activities against bacteria, yeasts and molds, and contribute to clean labels by allowing the removal of chemical additives such as benzoate and sorbate. “We have generated data across a wide range of food products, including soups, entrées and pasta; refrigerated deli salads (meat and non-meat); refrigerated dips, including salsa, sour cream and hummus; shelf-stable sauces and dressings; and bakery items, that shows cultured-sugar products are effective antimicrobials compared to the control and, in many cases, compared to other commercial fermentates and chemicals,” says Jarret Stopforth, technical services manager, Purac America, Lincolnshire, IL. “In addition, such fermentates were highly effective against most pathogens, including *Listeria monocytogenes*, *E. coli* O157, *Salmonella* and *Staphylococcus* in various food matrices.”

Stopforth also notes that, aside from their role in preservation and food safety, these ingredients “have demonstrated enhancement of flavors already present, such as spices, color protection, thickening properties, and creaminess and smoothness in various food applications.”

Keep in mind, however, any legal definition of “natural,” particularly in USDA-regulated products might disallow the use of any additives for preservation—natural or not—so make certain you know what rules pertain to your specific product.

As the food industry increasingly moves toward natural preservation, product developers must act as guardians to make sure it is not at the expense of food safety. Everyone should be cognizant of differences in mechanisms and efficiencies of natural preservative alternatives compared with conventional, proven product protection. Work in this area is quite active, so new research is continually being completed, and current solutions are being refined to meet the natural category’s growing needs.

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