Antioxidants: Firms seeking products they can use

The regulatory climate in the United States and growing consumer preference for "natural" products are causing the fats and oils industry increasingly to seek natural sources of antioxidants rather than to invest in synthetic antioxidants.

"There will be no new synthetic food antioxidants," Dan F. Buck, senior technical service representative for Eastman Chemical Products Inc.'s Health and Nutrition Laboratory in Kingsport, Tennessee, said during the 1990 AOCS annual meeting. Factors cited by Buck include growing consumer preference for "natural" products, the rising cost of new product research and development, the expense of conducting health and safety studies, and the time it takes for regulatory approval for new products. "Of course, synthetic no more means bad than natural necessarily means good," Buck added.

In a chapter on antioxidants planned for publication in the book Biotechnologically Derived Ingredients for Food Products by Van nostrand Reinhold Publishing Co., Joseph Fioriti of Kraft General Foods and retired colleague R.J. Sims note the number of synthetic antioxidants has remained static during the past decade, partially due to the time and expense involved in getting a new antioxidant approved. "In contrast, the activity in the field of natural antioxidants has been very pronounced," they wrote, adding that this development "has been fueled by the trend toward all natural ingredients and by some toxicity concerns."

Questions about the safety of synthetic antioxidants are increasingly plaguing the industry, forcing fats and oils product manufacturers to rethink their use of these products. One result has been a decrease in the use of synthetic antioxidants, with more interest in naturally derived antioxidants. Another trend has been a switch from the synthetic antioxidant butylated hydroxyanisole (BHA)—under attack in California as well as on the federal level—to other synthetics not currently under scrutiny. In some cases, formulators have eliminated the use of antioxidants.

"We have noticed more interest to cut down on additives in foods. Not many years ago, retail salad oils were typically partially hydrogenated and winterized, and often contained an antioxidant, typically TBHQ (tertiary butylhydroquinone), an anti-foaming agent and crystal inhibitor. Now, many are RBD (refined, bleached, deodorized) soybean oil containing no additives," according to Robert Wainwright, director of research and development for Karlshamns USA Inc. He noted that oil stability increasingly is protected by packaging using ultraviolet barriers and filling under nitrogen.

"We have been receiving more requests to limit additives in formulations or if necessary, to use all natural sources," he said.

Prompting such requests has been California's Proposition 65 which will require companies marketing products with BHA to provide a warning that they contain a chemical known to the state of California to cause cancer unless the exposure level poses no "significant risk." This legislation has sent shock waves through the industry, particularly as no one has determined what level of BHA would constitute "significant risk."

As a result, increasing interest has been shown in such materials as tocopherols, rosemary extracts and ascorbyl palmitate. Howard Gordon, senior technical services manager for Roche Vitamins and Fine Chemicals which is a division of Hoffmann-La Roche Inc., noted that companies are finding alternatives to BHA to avoid becoming "bad guys" in the eyes of the public. "If you're a large food company, you don't want consumer advocates pointing the finger at you and saying you are the villain," he said.

However, natural antioxidants available—tocopherols and herb extracts—have drawbacks, according to Wainwright. For instance, tocopherols generally are not as effective in vegetable fats and oils as they are in animal fats; some antioxidants from herbs and herb extracts often impart strong color or flavors. "It is a real challenge to industry to find suitable all-natural alternatives," Wainwright said.
Another drawback is cost. Natural antioxidants cost more than synthetics. Butylated hydroxytoluene (BHT), the cheapest antioxidant, costs approximately $1.80 a pound as opposed to $14.65 a pound for tocopherols. "Also, you'd have to use two to three times as much tocopherol to get the same effectiveness in some applications," according to Roberta J. Buford, national sales manager for UOP's Food Products and Processes Group.

The trend toward all natural is not just a U.S. phenomenon. Industry representatives note this is even more evident in Europe, where firms are selecting such natural products as mixed tocopherols and spice extracts or cutting down on antioxidant use in general. Because of the varying regulatory requirements concerning antioxidants from country to country, companies marketing products internationally especially are faced with developing formulations omitting synthetics.

"Companies, for instance, don't want to have different labels for California or Canada," Buford said.

**Why antioxidants?**

Antioxidants are used to protect fats and oils from developing rancid flavors and odors or from decomposing during storage. Oxidation of fat is accelerated by exposure to light, higher temperatures and oxygen concentration. Certain metals, metal-containing compounds and enzymes also contribute to rancidity development.

"Even the wrong type of stainless steel can introduce metal ions that initiate oxidation," according to Robert J. Evans, Kalsec Inc.'s market development manager.

Antioxidants also minimize the oxidative destruction of certain vitamins and essential amino acids, and prevent the spoilage of many foods containing fats or oils. They are used in shortenings, cooking oils, potato chips, breakfast cereals, and other foods, and are added to the packaging material for some products.

According to the report, "Antioxidants in Food in 85 Nations," published in January 1990 by Jan Dekker International BV, Holland, the prevention of rancidity in foods containing fats is more difficult than in fats alone because the fat is dispersed over a large surface. "In fact, it is advantageous to have several antioxidants available for use owing to their differences in fat solubility, heat stability and sometimes differing activity in different fats and oils," the report said.

Most useful are antioxidants that are soluble in fats and oils, odorless, tasteless, nontoxic at approved dosage levels and effective in low concentrations. Processing convenience and low cost are also factors. Food antioxidants have been used commercially for the past 40 years but their general use probably dates back to early man, who first used fire and smoke, and later spices and flavorings, to preserve foods. The first commercial antioxidants used in U.S. foods were gum guaiac and lecithin. However, these compounds currently find only limited use in foods because of their low antioxidant power and relatively poor heat stability.

Antioxidants are usually aromatic compounds which are phenolic in character. Phenolic antioxidants permitted in edible fats and oils in many countries include tocopherols, propyl gallate (PG), BHA, BHT and TBHQ; permitted levels vary from country to country. U.S. Food and Drug Administration (FDA) regulations generally allow PG, BHA, BHT and TBHQ or a combination to be used at a level not over 0.02% (200 parts per million) based on weight of the fat or oil; tocopherols and ascorbyl palmitate, which are used under good manufacturing practices (GMP), do not have a regulated limit. Meanwhile, the U.S. Department of Agriculture (USDA) has separate regulations allowing the same total, but no singular component can be over 0.01% (100 parts per million). Usage depends on the application. Under FDA and USDA regulations, antioxidants must be identified on food labels by their common names. Because only small amounts of antioxidants are added to food products, the cost of the antioxidant is

![Rosemary plant](Country-of-Home-Inc)
Antioxidants

only a minimal part of the total cost of the product marketed.

Current applications

Antioxidants are sometimes used to stabilize animal- and vegetable-derived fats and oils, including fish oils, lard and beef fat for human consumption and lower-grade tallow and greases for animal feeds. Vegetable oils stabilized with antioxidants frequently are used as frying fats. Effective stabilization of oils and shortenings extends shelf life of the end products in which they are used. Antioxidants cannot reverse oxidation nor regenerate a rancid product. Thus, it is crucial to add an antioxidant to a freshly produced fat or oil before the oxidation process has begun.

Antioxidants are available in solid and liquid blends. Liquid products offer the convenience of a presolubilized antioxidant in a carrier such as vegetable oil, propylene glycol or ethanol. The most widely used antioxidants are still the traditional synthetic products, with BHA, BHT, TBHQ and PG dominating the U.S. market. Some of the more popular combinations are BHA and BHT in vegetable oil for use in animal fats; TBHQ and citric acid in propylene glycol for protecting vegetable oils and foods fried in oils such as potato chips; or a blend of BHA, BHT, PG, citric acid, monoglycerides, propylene glycol and vegetable oil for use in sausage products.

BHA can be mixed with BHT, TBHQ or PG and the resulting synergism provides greater antioxidant potency than what would be expected from each individual antioxidant.

Synthetic vs. natural

What’s the difference between “synthetic” and “natural” in the antioxidant industry?

“Synthetic” refers to materials that have been chemically created, typically from petroleum products. “Natural” refers to all other compounds, often obtained from various plants or animal tissues.

BHA has been shown to have excellent carry-through activity after baking and frying to protect cooked foods. BHT can be used in combination with BHA, PG or TBHQ. BHT offers fairly good carry-through after baking and frying to protect the final cooked product. In 1977, FDA proposed to remove BHT from GRAS status and to permit its use in food or in contact with food on an interim basis pending additional study. However, that proposal was never finalized, and so BHT continues to be GRAS.

The newest of the synthetic antioxidants developed for fat and oil stabilization, TBHQ is recognized in the United States as offering good carry-through activity to protect fried food products against oxidative deterioration but is not effective for baked foods. It was approved for use by FDA in 1972 after being introduced by Eastman Chemical Products Inc. It is most effective in stabilizing highly unsaturated oils such as soybean, sunflower, safflower and fish oils. It also is an effective antioxidant for animal fats, nuts and confections. It is permitted for use with BHA and/or BHT but not with PG. Europe and Canada do not allow TBHQ in their foods because they claim there is insufficient safety data available on this antioxidant. In vitro studies at Purdue University have shown that TBHQ and BHA have the same degradation pathway.

PG, approved by FDA in the late 1940s, is the most effective of the synthetic antioxidants in preventing oxidative rancidity in animal fats, according to Buford. However, she added, it can be the most problematic due to the possible formation of black or purple color complexes when coming into contact with metallic ions such as iron or copper. “To prevent this color formation, liquid blends are offered in a propylene glycol solution combining propyl gallate with a chelating agent such as citric acid,” Buford said. PG is most effective with BHA and BHT, but cannot be used with TBHQ.

Other chelating agents besides citric acid that are used to inactivate metals in fats and oils include lecithin and ascorbic acid.

Furor over safety

Currently under fire in the United States, the synthetic antioxidant BHA has been identified as a carcinogen in laboratory animals by the International Agency for Research in Cancer (IARC). Due to IARC’s ruling, the forthcoming 6th Annual Report of the National Toxicology Program and California’s Proposition 65 list BHA as a carcinogen. Placing BHA under such a listing effective Jan. 1, 1990, California is slated to require products containing BHA at levels that pose a significant risk of cancer to carry a warning starting Jan. 1, 1991.

Under California’s existing “safe harbor” provisions, foods and other products regulated by FDA that comply with all applicable state or federal standards are exempt from carrying a warning. However, a court ruling in March 1990 held that California’s “safe harbor” provisions were invalid. The Grocery Manufacturers of America (GMA), the Cosmetic, Toiletry and Fragrance Association (CTFA) and other industries subject to FDA regulations subsequently are appealing that decision.

“Without ‘safe harbor,’ products would be subject to giving warning of significant risk, and yet the state has not defined what levels signify significant risk. People are then left to make their own determination and then justify their action if ever challenged,” according to Sherwin Gardner, GMA’s vice president for science and technology. Gardner predicted that oral arguments on the appeal probably won’t begin until mid-1991. Until the appeal is settled, the “safe harbor” provisions stay in effect.

Steven A. Book, science advisor to the Secretary of California’s Health and Welfare Agency, noted that companies relying on the “safe harbor” provision should be sure they can demonstrate no significant risk.
“quantitatively.” He added, “A level of exposure which poses ‘no significant risk’ is defined as one which is calculated to result in not more than one excess case of cancer in 100,000 individuals exposed over a 70-year lifetime.”

Representatives from BHA manufacturers and industry users met with representatives of the California Department of Health Services Sept. 13 in Berkeley to share information about BHA in the hopes of working out risk assessment levels. Predicting that California for political and legal reasons probably won’t delist BHA, Keith Aspray, manager of UOP’s Food Products and Processes Group, said, however, that the state could possibly add a parenthetic clause saying that only when used above a certain level would products containing BHA need to carry warnings.

Because of BHA’s tenuous standing in California, some formulators are switching from BHA to combinations of PG and BHT or BHT and TBHQ. According to Buford, a number of manufacturers switched from BHT to BHA after FDA began questioning BHT’s safety in 1977. “Now, we see some switching from BHA to BHT,” she said. A spokesman for Neville-Synthese Organics Inc., a subsidiary of Rhône-Poulenc which is one of the major BHT manufacturers, however, noted his company has seen no substantial increase in BHT sales since the California action against BHA.

Safety questions concerning BHA first arose in 1982, after Nobuyuki Ito of Nagoya City University Medical School, Japan, reported findings showing BHA to be carcinogenic in F344 rats. However, other research showed BHA might block cancer formation. Experts attending an international conference on food antioxidants in April 1986 organized by the International Life Sciences-Nutrition Foundation’s Antioxidants Technical Committee agreed that despite findings indicating antioxidants such as BHA may cause or promote tumors in the forestomach in rats, they appear to be safe for human use at current levels. They recommended more studies be conducted to resolve conflicting evidence of anticarcinogenic and antimitogenic properties of antioxidants on one hand and tumor promotion on the other.

The Joint Expert Committee on Food Additives of the World Health Organization has said food antioxidants are safe at existing concentration levels in foods, a stand echoed by FDA.

However, FDA in June received a petition from an individual requesting that it ban all food uses of BHA, including action to revoke its GRAS (generally recognized as safe) status. The petitioner—Glenn Scott of Cooperstown, New York—based his petition on studies implicating BHA in causing papillomas and squamous cell carcinomas in the forestomach of rats;

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Forestomach papillomas and carcinomas in hamsters; forestomach papillomas in mice; liver and esophagus changes in monkeys; esophagus changes in pigs; and changes in the lungs of Japanese house musk shrews. "If food processors believe preservatives are necessary in their products, there are many alternatives to BHA," Scott wrote, citing citric acid and potassium sorbate as two choices.

Food industry representatives, however, note that citric acid and potassium sorbate are not antioxidants per se, but are chelating agents. Meanwhile, in Korea, researchers at the School of Medicine at Inha University have reported BHA produced hepatic tumors in fish but that tumor incidences were clearly dose-dependent.

FDA has said it will take no action on Scott's petition until it receives more information clarifying a Japanese BHA study with house musk shrews which was cited by Scott.

Meanwhile, current procedures for gauging carcinogenicity are coming under increasing scrutiny and criticism, with some scientists questioning the validity of administering high doses of chemicals to rodents and then extrapolating the results to the effects of minuscule doses in humans. Researcher Bruce Ames of the University of California at Berkeley, in the Aug. 31, 1990, issue of Science, argued against such methods and pointed to the fact that virtually all chemicals are toxic if ingested in sufficiently high doses.

"Much misleading information has been given to the public and to industry based on studies of food additives, done at very high dosage levels, when other studies have shown that at low levels these substances are safe and may even be beneficial as anticarcinogenic agents," according to Edwin N. Frankel, adjunct professor with the Department of Food Science and Technology, University of California at Davis.

Natural alternatives

Meanwhile, alternatives to synthetics are commercially available in the United States, although most are generally more costly and in some systems are less effective. Just because an antioxidant is obtained from a natural source does not prove it is safe. Newly identified natural antioxidants, like other new food additives, must undergo rigorous toxicological tests before they can be approved. Natural materials such as spices currently are marketed as flavorings with antioxidant properties.

Extracts from natural vegetable sources which show promise as antioxidants for fats and in food systems include tocopherols, phospholipids, spices, proteins, amino acids, browning reaction products, flavones and isoflavones, according to Fioriti and Sims, adding, "To date, rosemary extract, phospholipids and tocopherols have found some practical applications."

Cheryl J. Megremis, product manager for Henkel Corp.'s Fine Chemicals Division, noted that worldwide use of tocopherols currently is estimated to exceed 150 metric tons annually.

Tocopherols have been found to be effective in stabilizing animal fats. Because different vegetable oils vary in their actual tocopherol content, the effectiveness of adding tocopherol to vegetable oils, however, depends on the oil. Since unsaturated vegetable oils already contain significant quantities of tocopherols, incorporation of additional amounts does not prolong the induction period significantly, according to Fioriti and Sims. However, the addition of tocopherols can be considered when carry-through—the resistance to loss of antioxidants due to vaporization—or maintaining the quality of an oil over a prolonged heat-stressed period is an important factor. In Japan, tocopherols are estimated to represent 50% of the antioxidant market.

Megremis noted that tocopherol performance in vegetable oils is system-dependent. "We fried oriental noodles in palm oil and increased the stability of the noodles two-fold, yet stability of the palm oil itself increased only 35%," she said, adding, "An advantage of using tocopherols versus synthetics is there are no usage level restrictions. Thus, you can use more if you feel you need it. Health safety is not an issue."

However, studies have shown that high levels of tocopherols sometimes result in prooxidant effects. In his early studies at the U.S. Department of Agriculture (USDA), Frankel was one of the first to show that natural tocopherols at high levels have a prooxidant effect in soybean oil. He and his coworkers at USDA's Northern Regional Research Center (NRRC) showed that tocopherol concentrations between 400 and 600 parts per million yielded optimum soybean oil stability. Megremis said Henkel currently is conducting studies to better understand prooxidation associated with tocopherols.

Buford of UOP noted that levels of natural tocopherols greater than 1,000 parts per million based on oil or fat content may have a prooxidant effect.

Tocopherol mixtures of various compositions are available commercially in the United States from such companies as UOP, Henkel Corp.'s Fine Chemical Division and Eastman Chemical Products Inc. Roche Vitamins and Fine Chemicals, a division of Hoffmann-La Roche Inc., synthesizes and sells dl α-tocopherol and ascorbyl palmitate and has ongoing studies on the efficacy of γ-tocopherol. Synthetic dl α-tocopherol costs the least of all the tocopherols. However, a drawback is that, like the natural tocopherols, it can become a prooxidant at higher levels. γ-Toco-
Antioxidants

Tocopherol concentrates are mixtures of the various tocopherol homologs derived from soybean or other vegetable oils. Commercial products generally are 50% or 70% concentrates. Meanwhile, the new synthetic high purity dl-\(\alpha\)-tocopherol recently has been promoted in Europe.

NRRC researchers are among those still studying the effectiveness of tocopherols. "Our research leads us to think a combination of the four tocopherols might give a designer antioxidant," according to NRRC food technologist Kathleen Warner. Some tocopherols protect oils from photooxidation; others are more effective in preventing autoxidation. "Bottles of oils are exposed to both on the grocery shelf, so a combination of these tocopherols could be quite effective," Warner said.

In the future, plant geneticists, who currently are conducting research to manipulate the fatty acid composition, may be able to manipulate the natural tocopherol content, Warner said.

Gordon said Roche has received increasing inquiries about using \(\alpha\)-tocopherol and ascorbyl palmitate, an ester of vitamin C. "Ascorbyl palmitate is very effective in vegetable oils and is GRAS," he noted. Another choice is to combine alpha tocopherols and ascorbyl palmitate. Gordon said, noting Roche has found a synergistic effect in its studies with such combinations. Roche also is looking at applications for pure \(\gamma\)-tocopherol. Evans noted that in parts of the Far East and Europe, ascorbyl palmitate and sodium ascorbate have been given essentially the same regulatory status as that for natural products.

Meanwhile, such spices as clove, cinnamon, sage, rosemary, mace, oregano, allspice and nutmeg have demonstrated highly antioxidant properties and strong synergism when combined with BHA. The only spice commercially available for use as an antioxidant in the United States is rosemary. However, because of their prime use as flavoring agents, rosemary extract products are not technically listed as natural preservatives or antioxidants.

Rosemary extracts have been used commercially in processed foods for over 30 years. It was not until Stephen S. Chang—currently professor emeritus of Rutgers University—and colleagues at Rutgers developed and patented a process to concentrate natural antioxidants from rosemary and sage by solvent extraction and subsequent steam, vacuum distillation of the extract in an edible oil that rosemary extracts were available without imparting bitter flavor and rosemary odor to the finished product. Chang's work subsequently showed the efficacy of these deflavored extracts in retarding soybean oil reversion and in reducing hydroperoxide development in lard as well as in potato chips fried in the oils containing the spice extracts.

Kalsec Inc., which has the exclusive license to use this patent, modified procedures to reduce color in its rosemary extract which is said to effectively retard oxidative rancidity, warmed-over flavors and color degradation in snack foods, mayonnaise, salad dressings, citrus oils, processed meats, poultry and seafood. Kalsec manufactures two types of rosemary extracts with oxidation inhibitors: an oil-soluble extract and a water-dispersible extract. UOP, meanwhile, has three rosemary extracts with antioxidant properties; all are natural rosemary extract oleoresin flavors. Fritzische Dodge & Olcott Inc. also manufactures rosemary extracts with antioxidant properties. Other manufacturers include Pfizer Inc. and Nestlé Food Corp. In Europe, rosemary products reportedly represent about 40 to 50% of the antioxidant market.

Drawbacks to using rosemary, however, include its high cost relative to the synthetic antioxidants and the larger quantities that often must be used to obtain the same effectiveness. For instance, marine oils, which are highly unsaturated, require the addition of high levels of rosemary extract. Rosemary extracts also must be used at higher levels than TBHQ to obtain the same amount of effectiveness in vegetable oils. Even so, demand for rosemary extract antioxidants continues to grow.

**Other potential antioxidants**

Although rosemary extracts and tocopherols are the most popular natural antioxidants on the market, Chang believes tea extracts will become even more promising.

Chang has a patent pending in the United States on natural antioxidants derived from tea. According to Chang, the proposed patent is for a process to produce an oil-soluble natural antioxidant which is odorless and tasteless as well as highly effective.

Citing growing consumer demand for natural products and published studies showing possible harmful effects in animals from synthetic antioxidants, Chang said he believes natural antioxidants eventually will replace synthetic antioxidants.

Meanwhile, researchers in Chile have been investigating the use of flavonoids as stabilizers of fish oil. Among the commercially available flavonoids tried, quercetin was shown to exhibit a marked antiperoxidative effect. Reporting on their work in a poster presentation at the Second International Conference on the Health Effects of \(\omega-3\) Polyunsaturated Fatty Acids in Seafoods earlier this year, researchers noted the potential of flavonoids, added as single species or in mixtures or with other antioxidants.

Others, however, caution that because flavonoid content in plants is...
Antioxidants

The current trend toward natural has raised several questions. One centers on the correct terms that should be used for these materials.

FEATURE

low, producing them for antioxidant use would be expensive. Also, some show toxicity problems.

Dan Pratt, professor in the Foods and Nutrition Department at Purdue University, said he has looked at 50 to 60 sources for natural antioxidants over the past 30 years. "Chia, which grows in desert southwestern United States and in Mexico, contains protective phenolics that are chiefly flavonoid compounds," Pratt said, noting that because the plant is not abundant, there is no movement to commercialize chia-derived antioxidants. However, researchers at Nestle said they are examining the antioxidant potential of chia oil.

Pratt noted that quercetin, the most common flavonoid, has been shown to be a mutagen in the Ames test but not a carcinogen. The biggest disadvantage with flavonoids, he said, is that they exist in plants in the form of a glycoside. "They're not oil-soluble, but are water-soluble. This would be a disadvantage as an antioxidant," Pratt said.

Researchers at the Swedish Institute of Food Research (SIK) have been among those examining the potential antioxidant properties of Maillard reaction products (MRP). Hans Lingnert and colleagues particularly have looked at antioxidative MRP from histidine and glucose. They also have studied MRP from peptides and xylose, and from protein hydrolysates and glucose.

"The antioxidative effect has been established in model systems with linoleic acid emulsions but also in storage experiments with various foods such as cookies, milk powder and frozen sausage," according to Lingnert. Noting there currently is no commercial production of MRP as antioxidants, he added, "However, the food industry makes use of the fact that antioxidative MRP may be formed in heat processes." Lingnert said the main disadvantage is color. "In our attempts to isolate antioxidative fractions of MRP, we have never been able to get noncolored fractions with high antioxidative effect, even though it is possible to improve the ratio of antioxidative effect to color."

Other studies have shown branched-chain peptides combined with reducing sugars—especially xylose—to have high antioxidant activity as measured by peroxide values. Meanwhile, a leucylglycine-xylose combination was effective in preventing oxidation with various vegetable oils.

Looking at extending the shelf life of fish oil products, L.R. Schroeder and colleagues at General Mills Inc. have obtained a patent for stabilizing fish oil without heat treatment by incorporating fructose.

Still other research has shown synergism between protein hydrolysates and BHA, BHT, alpha tocopherol, pli-catic acid, caffeic acid, hydroquinone and PG. "The hydrolysates are primary antioxidants since their effect is concentration-dependent and not due on oat oil and its fractions. In an article published in the August 1990 issue of the German publication Fat Science Technology, P. Forssell, G. Wirtanen and Y. Mäkkki of the Technical Research Centre of Finland and M. Cetin of Horhor Cesme, Turkey, verified antioxidative effects of oat oil and its fractions on lard, tallow and soybean oil. Concluding that both oat oil and its polar fractions show potential

The current trend toward natural has raised several questions. One centers on the correct terms that should be used for these materials.

for use as antioxidants, the authors said further work is needed to evaluate their practical application.

Meanwhile, at Iowa State University's Department of Food Science and Human Nutrition, Pamela J. White has been overseeing studies on possibly using oat antioxidants in frying oils. "The intent of our work is for possible commercial applications," White said, noting that the studies have concentrated on quick extractions with solvents "to produce something useful at a low cost" for frying applications.

"The usefulness depends on so many factors," White said, citing such items as the oil used, synergistic effects with citric acid and differences if used in an emulsion or if the product is baked.

Other questions

The current trend toward natural has raised several questions. One centers on the correct terms that should be used for these materials.

"The time may be at hand to promote alternate terminology for the natural free radical interceptors," Evans said, noting that natural materials used should be referred to as lipid stabilizers or oxidation inhibitors, ver-
sus antioxidants. "The body of U.S. law regulating synthetics like BHA and BHT is specific in its use of the term 'antioxidant' as a generic term describing the synthetic phenolics. In practice, it should not apply to the naturally occurring inhibitors such as the chelating acids, lecithin and spice extracts. There is merit in adopting alternate functional terminology, such as chelating agent, oxygen absorber and free radical scavenger, to describe these categories of natural foodstuffs. In this way, unintended application of regulations governing synthetic 'antioxidants' may be avoided."

Pratt, however, said that from a chemical point of view, "If the reaction type is the same for synthetics and natural antioxidants, they should be called by the same terminology."

Frankel, meanwhile, is concerned with some of the tests done to compare the performance of various antioxidants and believes better methodology is needed to evaluate oxidation and stability. "Many are tested at very high temperatures, yet the validity of results obtained at high temperatures is questionable," Frankel said. He noted that potential antioxidants should be tested at several temperatures and with several techniques. "When you evaluate vegetable oils, you can get completely different results at high and lower temperatures. Because the higher temperatures accelerate oxidative conditions and give too many side reactions, I believe the lower temperatures are more valid," Frankel said, noting most of his testing is done between 40–60°C.

As industry turns increasingly to eliminating or minimizing antioxidants, Frankel has another concern. "The benefits of using antioxidants outweigh the risks. Without antioxidants in foods, oxidation products are created, causing a greater risk to health than the possible hazardous effects of synthetic antioxidants," Frankel said, citing evidence that degradation products may be toxic and can affect the safety of lipid-containing foods. He added, "I think the public and industry have over-reacted."

This article was written by Barbara Fitch Haumann, Senior Editor/Writer for INFORM.