Next Generation Nutraceuticals

Whether familiar (zinc, selenium) or little known (CoQ10, phosphatidyl serine, astaxanthine), emerging ingredients and botanicals are waiting for processors to discover their untapped potential.

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SOURCE: INNO-BEV LTD.

The market for nutraceutical ingredients outside the U.S. has been built on a long history of preventive health that encourages incorporating botanical and other health-promoting ingredients into foods and beverages. Today's global market is opening channels for such products to North American consumers.

Although most micronutrients are anything but new, some have been newly emphasized as a result of recent studies. In addition, there always is ongoing research into phytochemicals (bioactive plant chemical compounds) that—although not considered essential nutrients—still demonstrate healthful properties. More than 20,000 phytochemicals have been identified; most, along with other, non-plant-derived nutraceuticals, are underused in food and beverage processing.

The list of such hidden health treasures only keeps growing. But, the good news is that some of the more interesting of these "orphan" ingredients have reached, or are soon reaching, the tipping point that gets them beyond the bench and onto supermarket shelves. Some have yet to acquire GRAS approval and so must bear the same label disclaimers as nutritional supplements. Others have had GRAS status for years, but for one reason or another, have not yet made the leap to foods and drinks. Still others are in a few products, or only available outside the U.S. at this time. All bear scrutiny for what they can offer new product developers in the way of an edge on the next trend.

Addressing the hot-button issue of cognition and memory is phosphatidylserine, one of a class of structural fats called phospholipids. These fats make up all biological membranes. They have the unique ability to allow water to interface with lipids. Fats and cholesterol are carried through the water medium of the blood by lipoproteins, which are spherical droplets made mostly of phospholipids. They also are the natural model that inspired liposome technology, which disperses fat-soluble micronutrients and phytochemicals into aqueous liquids.

In the body, phosphatidylserine is found predominantly in brain cells. It plays a role in multiple functions of activity in the neurons. Research has focused on its impact on memory and learning ability. As a nutraceutical, it first gathered attention after studies on rats suggested it could help prevent cognitive decline. It attained GRAS affirmation in 2003 and is typically derived from soy lecithin.

Although not all studies have confirmed this, the FDA was sufficiently satisfied by the research to allow two qualified health claims: 1) "Consumption of phosphatidylserine may reduce the risk of dementia in the elderly. Very limited and preliminary scientific research suggests that phosphatidylserine may reduce the risk of dementia in the elderly. FDA concludes that there is little scientific evidence supporting this claim;" or 2) "Consumption of phosphatidylserine may reduce the risk of cognitive dysfunction in the elderly. Very limited and preliminary scientific research suggests that phosphatidylserine may reduce the risk of cognitive dysfunction in the elderly. FDA concludes that there is little scientific evidence supporting this claim."

Some evidence suggests that phosphatidylserine might benefit athletes by reducing soreness and shortening

SOURCE: LYDIA'S ORGANICS INC.

Although spirulina is not exactly a new ingredient—the vitamin K-rich *cyanobacteria* was huge in the 1970's health food scene—the ingredient is re-emerging with vigor as a detoxifier and energy source.

recovery. Since phosphatidylserine is a phospholipid and an emulsifier by nature—much like lecithin that carries the scientific name phosphatidyl choline—it may be incorporated into foods, such as bars, chocolates and dairy products, especially yogurts.

In the Pink

Ever wonder why some cooked seafood turns red or what makes pink flamingos pink? A little-known and highly powerful antioxidant, astaxanthine, is the source. Astaxanthine is a carotenoid similar to β-carotene, except it yields a red color and can't be converted to vitamin A. It's also not readily available in garden vegetables, but rather derived from a type of microalgae. In nature, astaxanthine is found in organisms that eat microalgae. From small creatures, it works its way up the food chain—from krill, shrimp, crayfish/other crustaceans, trout and salmon—and leaps to land in the feathers of some birds which feed on shrimp.

Astaxanthine also is present in yeast. Though this fat-soluble molecule can be synthesized, the natural source, mostly from the microalgae *Haematococcus pluvialis*, is preferred. It is used as a food-coloring agent, a natural feed additive for the poultry industry, and for products of aquaculture, especially farmed salmon, trout and shrimp, to give them the familiar color they have in nature.

Although still largely sold as a food supplement and cosmeceutical, astaxanthine attained GRAS rating by the FDA in 2010. Scientists have been researching it for many potential benefits in human nutrition. According to a 2011 review article in the journal *Molecular Nutrition and Food Research*, these benefits include anti-cancer, -diabetic and -inflammatory properties (especially important for joint health).

Also being studied are astaxanthine's potential protective effects on various organs, such as the stomach, liver, heart and blood vessels, eyes and skin, plus its effects on the nervous system. Its antioxidant capacity—by some studies, more than 500 times stronger than vitamin E and much more potent than fellow carotenoids lutein, lycopene and β-carotene—is all the more attractive because of its apparent inability to switch over and act as a pro-oxidant.

Outside of the U.S., astaxanthine has appeared in a number of beverages, and it's just beginning to make inroads in similar formulations here. While its beauty-from-within abilities have left it in high demand, makers of the ingredient have been ramping up production, thus increasing availability.

What's Old is New Again

Some "oldies" in the nutraceutical panoply have been making comebacks–specifically, gingko for memory and cognition; guarana, ginseng and yerba maté for energy; and spirulina for energy and other health benefits. The following nutraceuticals are experiencing a big spike in usage in energy and sports beverages/bars. Could they land in a wider variety of products in the next few years? That's for trend-savvy processors to determine.

More to Watch

Ingredient	Class	Health Target
Garcinia cambogia	Botanical	Metabolism
Gingko biloba	Botanical	Memory and cognition
Ginseng	Botanical	Energy
Glucuronolactone	Vitamin C precursor	Connective tissue; detoxification
Guarana	Alkaloid	Energy
Maca	Tuber	Central nervous system; source of selenium, zinc and other trace minerals
Opuntia (prickly pear)	Botanical	Energy; inflammation; digestion
Polyphenols	Antioxidant	Cardiovascular; nervous system
Spirulina	Cyanobacteria	Detoxicant; vitamin K source
Taurine	Amino acid	Cardiovascular; cancer; inflammation
Yerba maté	Alkaloid	Energy

A light and fizzy drink with bioreactive botanicals and Co-Q10 puts Go Girl Energy Drink's Sweetie Grapefruit variety squarely in next-generation nutraceutical territory.

SOURCE: NOR-CAL BEVERAGE CO.

Co-Q Train

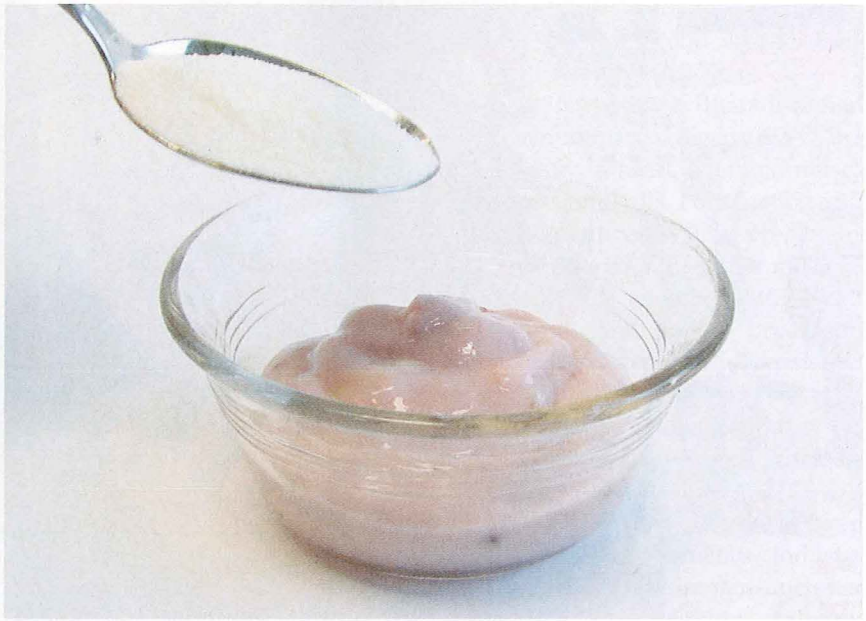
Coenzyme Q10 (Co-Q10) has taken more than half a century to become an overnight sensation. Although technically not classed as a micronutrient, (it is made by every cell in the body) for today's energy-stressed Boomers, it's becoming a dwindling resource.

Co-Q10 serves two vital functions in the body. Its primary role is to participate in synthesis of adenosine triphosphate (ATP), that is, the creation of energy from food. Secondarily, it functions as an antioxidant. This is why the body makes much more Co-Q10 than can participate in the energy-creating electron transport chain. Age, disease and a variety of modern stresses place demands on antioxidant systems. Co-Q10 levels in human organs, like heart, liver and kidney, tend to peak in the second decade of life and drop off steadily from there.

There are few studies that document naturally rich sources of dietary Co-Q10. It is found mostly in heart, liver and muscle meats, seafood and oils. Fortification with Co-Q10 was traditionally hampered by the fact that it's a large, fat-soluble molecule and difficult to absorb. But, recent developments in food processing technology greatly expanded the potential targets for Co-Q10 fortification.

In a 2010 article in *Critical Reviews in Food Science and Nutrition*, a number of techniques for increasing the water solubility of Co-Q10 were presented. Most of these were developed for the cosmetics industry. However, food manufacturers are interested in techniques that don't add unwanted chemicals to the food label. Enter starch.

Starch-based hydrophilic (water-loving) coatings allow Co-Q10 to be incorporated into stable solutions (or "dispersions") in



SOURCE: BIOENERGY LIFE SCIENCE INC.

Ribose is not metabolized like sugar and, therefore,provides no calories, but is half as sweet as sucrose. It is readily soluble in water and has no aftertaste. It is compatible with many ingredients and systems to include: other sugars, carbohydrates, fiber and sweeteners in formulations, most protein-based systems, fats and oils found in food, and chocolates and coatings.

water. For example, small Co-Q10 beadlets coated with starch-based granules can be dispersed into a water-soluble fish gelatin matrix. Cyclodextrin, starch derivatives in the shape of a ring with a proven record of safety in the food industry, also are affective at dispersing Co-Q10 in liquids.

These dispersions change none of the organoleptic properties of foods fortified with Co-Q10, which allows its incorporation into a variety of products, such as milk, yogurt, kefir and other dairy products; fruit juices, tea and other beverages; syrups and honey, etc. Water dispersions of Co-Q10 are reported to have increased bioavailability and can more easily be incorporated into animal feed. Co-Q10-fortified eggs anyone? It's not far-fetched: The success of omega-3 fatty acids in eggs has been phenomenal.

Botanical Growth

With an unending list of plant species from which to draw, ingredient makers continue to find the scientific backing for millennia of the medicinal "herblores" that have grown from every culture. With so many thousands of possible bioactive ingredients in varying states of development as food and beverage possibilities, it's tough to pick the next big trend.

However, borage, also known as starflower, is one worth looking at as a contender for its omega fatty acids. Flax, chia and now perilla seed extract have cleared the path for plant-derived omegas, putting borage in a good position to join the party.

Borage has a long history in traditional medicines, both the plant and the seed oil. The oil contains a unique fatty acid called gamma-linolenic acid (GLA), an isomer (same formula) of alpha-linolenic acid (ALA), the omega-3 fatty acid found in flax and other oils. GLA is unusual, in that it is an omega-6 fatty acid that has anti-inflammatory properties. (Generally omega-6 fatty acids are pro-inflammatory).

Because of its potential anti-inflammatory properties, borage oil has been used as a treatment for conditions like eczema and rheumatoid arthritis, and it is most popular as a reliever of pains and discomfort associated with the menstrual cycle. A 2011 Cochrane Review paper showed that GLA from borage oil or evening primrose oil could reduce the pain associated with rheumatoid arthritis.

Polyphenols from grape seed extract have been known for years to have strong antioxidant effects. But, new studies indicate grape seed extracts have positive effects on blood pressure in persons with pre-hypertension and hypertension, as well as metabolic syndrome. Their increasingly recognized health benefits and ease of incorporation into formulations point to establishing grape seed extract as a favored ingredient for use in beverages.

Heavy Metals

Zinc is hardly an orphan ingredient—the metallic mineral is in many fortified foods. However, Americans

SOURCE: POLYPHENOLICS INC.

There are more than 20,000 identified phytochemicals known, yet only a fraction of a percent have made their way as food and beverage ingredients. The phytochemical compounds in grapes alone, number several dozen. They include the antioxidant polyphenols known as anthocyanins, flavonols, quercetin, epicatechin and procyanidin.

See Food Master-*INGREDIENTS*, p. 91

still have a zinc deficit. In fact, it's estimated that some 65% of the population isn't getting enough of the mineral in the diet. Zinc is classed as a trace mineral, which means people require less than 20mg per day. But, don't be fooled by the small amount.

Zinc acts as a co-factor for more than 300 different enzymes, making it critical to an astonishing array of functions, including sexual maturation, growth and development, the immune response, neurological function and reproduction. It also can affect gene expression.

See Food Master-*INGREDIENTS*, p. 41

Researchers from Tufts University presented evidence that suggests low zinc status could be a new risk factor for pneumonia in the elderly. Zinc is widely distributed in many foods, but not necessarily the foods that are high priority for elderly citizens, especially those with limited income. The best sources are oysters and high-protein foods, like meat, soy and other beans; and peas, lentils and nuts, including peanuts. Only about 25% of zinc provided by the U.S. diet comes from grain and grain products, which often dominate the diet of the elderly.

Many ready-to-eat cereals contribute 10% of the daily allowance for zinc per serving. Dairy beverages, meal replacements, sports drinks, some fruit juices, candy bars and confectionery products may be fortified with zinc. For adults, the RDA for zinc is 9-14mg per day, with a tolerable upper limit of 40mg per day. Zinc absorption can be compromised by high levels of phytates in food and supplements of iron and copper.

The challenge of fortifying foods with zinc is taste; it can leave a distinct metallic aftertaste on the tongue. A popular form of the mineral is zinc gluconate, which dissolves easily for many applications.

More Trace Minerals

Selenium is a trace mineral required in extremely small amounts—micrograms as opposed to milligrams. Incorporated into a molecule called glutathione peroxidase, selenium is unique, in that it acts as one of several antioxidants protecting membranes from damage—along with vitamin E. There are two salts generally used for selenium fortification. For example, in areas of China were selenium deficiency was endemic, sodium selenite was added to salt.

Sodium selenite is the less-soluble and more-stable selenium salt used as in some sports drinks (around

10µg/l) and to fortify infant foods. Protein-bound selenium, as selenomethionine, remains in the body longer than the selenium salts and could pose a risk for toxicity. As with zinc, selenium deficiency may impair immune function.

The history of chromium as a necessary trace element goes back to the mid-1950s, when rat studies showed that inorganic chromium complexes restored glucose metabolism in rats who suffered induced glucose intolerance (via the toxic torula yeast). Chromium was declared the missing "glucose tolerance factor."

Since that time, chromium supplements have been used for prevention and treatment of type-2 diabetes, and chromium picolinate has been promoted as a fat-burner and muscle-builder, due to its purported ability to enhance insulin sensitivity (the tendency to take glucose out of the blood in response to insulin).

Magnesium also is a metallic mineral garnering an upturn in attention. Approximately 60% of the adult population in the U.S. fails to meet recommendations for magnesium. There are several contributors to this low level of intake: Foods rich in magnesium, such as green vegetables, whole grains, seeds and legumes, are generally scarce on the fast-food menu.

Type 2 diabetes and metabolic syndrome tend to increase magnesium excretion. Mild-to-moderate magnesium deficiency also contributes to chronic inflammatory stress, affecting diseases like atherosclerosis, hypertension, osteoporosis and cancer. Excessive alcohol intake and any condition that compromises digestion can reduce absorption of magnesium

SOURCE: BIOENERGY LIFE SCIENCE INC.

Single serving contains 24 organic superfruits, veggies, sprouts and fruits; Golden Chlorella Omega (a complete nutrient-dense green food); organic maca; bioenergy ribose; and rhodiola extract.

SOURCE: DSM FOOD SPECIALTIES

The market for functional foods is growing, spurred by the need to alter the modern diet as well as by research advances. Scientists still are retrieving new functional ingredients from natural foods.

from the diet. There are many magnesium salts available that do not affect the flavor of beverages.

Fiber and Sugar

Americans get about 15% of the dietary fiber recommended by most nutritionists—even less if they are swayed to live on a "low-carb" diet. Specific grain fibers are linked to reduced risk of cardiovascular disease (CVD). Beta-glucans represent a unique form of soluble fiber that exists at the outer border of the endosperm of oats and barley. A glucose polymer that differs from starch and cellulose (insoluble fiber) by the bonds that hold the glucose sugars together, β-glucans have been shown in studies to lower both total cholesterol and LDL cholesterol.

Soluble fibers bind bile acids that are made by the liver from cholesterol and stored in the gallbladder. Bile acids are introduced into the small intestines to aid in fat digestion. Soluble fiber binds bile acids and prevents them from being recycled, which forces the liver to pull cholesterol out of the blood to make more bile acids.

Beta-glucans, as a soluble fiber, bind water and add texture and viscosity to foods, making them perfect candidates to double as thickening agents. The FDA's recommended consumption of about 3g β-glucans per day gives the best results for lowering plasma cholesterol. Beta-glucans also serve to slow the movement of food through the small intestines, reducing the absorption rate of sugar.

Meanwhile, there are two sugars not getting much attention, but for different reasons. Ribose is a 5-carbon sugar that the body makes as the base of important compounds such as DNA, RNA and ATP, the molecule referred to as the energy currency of the body. Any reaction that requires energy needs ATP. The body stores of ATP are very limited. There's a small backup system of high-energy molecules to help regenerate ATP, but this lasts only seconds.

There now is evidence to suggest that ATP-depleted muscles respond favorably to ribose supplementation that can help muscle cells recover from stress by supplying the base carbohydrate for ATP synthesis. This has great potential to benefit heart patients, increasing the power of heart muscle contractions that send blood on its destination. Ribose is not metabolized like sugar and, therefore, provides no calories, but is half as sweet as sucrose. It is readily soluble in water and has no aftertaste.

Another molecule, d-tagatose, that carries a calorie value about one third that of sucrose (table sugar), is similarly sweet and a naturally occurring sugar. It's present in small quantities in some fruits and dairy products and is about to make an appearance as a new sweetener. Poorly digested in the small intestines, tagalose acts as a prebiotic in the colon. It therefore has a minimum effect on insulin secretion or blood sugar.

Some studies show that tagatose could increase liver glycogen stores and decrease absorption of glucose from the small intestines. With sweetness similar to sucrose, it can be derived from lactose on an industrial scale. Lactose is a disaccharide made of glucose and galactose, the immediate substrate of D-tagatose that results from treating the galactose in a manner that rearranges the molecule.

The market for functional foods is growing, spurred by the need to alter the modern diet and the advance in research that retrieves functional ingredients, of which there seems to be an endless supply, from natural foods. Formulators, as well as marketers, have a great deal to gain by taking advantage of the ingredients on the outer edge of the spectrum and being on the vanguard of the trend wave when the former bit-player ingredient finds itself ready for prime time. NS