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Energy Beverages

Energy beverages are more in demand. PF looks at trends, plus the pros and cons, of the ingredients that give these bevs their revs.

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Energy beverages used to be one-trick ponies -- fast ponies, but not much else. This is because they primarily relied on caffeine. And, while many of them still do, the number of consumers demanding non-caffeinated power was expanding enough to encourage change in a big chunk of the multi-billion dollar business that is energy drinks and shots.

Modern energy drinks can be divided into roughly five categories, based on key ingredients. Caffeinated drinks fall into a category of alkaloid-enhanced beverages. In addition to caffeine, this also includes ingredients such as the other xanthines, theobromine, theophylline and muirapuamine (from *Muira puama* bark), and alkaloidal compounds derived from extracts of *catuaba* bark.

Related, but non-alkaloidal, botanically derived compounds make up a second category. This includes ginseng,

gingko, schizandra berry (*Schisandra chinensis*) and newer (to U.S. culture) plants and plant-derived compounds, such as angelica root, vinpocetine, bacopa and icariin, a flavonoid compound from the evergreen epimedium plant family. Icariin acts as a vasodilator and relaxes smooth muscle fibers via an increase in nitric oxide. Pharmaceutically, it is similar to Viagra. Antioxidants, including polyphenols and green tea extracts (for example, catechins such as epigallocatechin gallate, or EGCG), also fall into this category. In addition to their stimulant effect, many of these compounds have secondary actions of increasing concentration, focus and enhancing memory.

Then there are drinks using amino acids, such as taurine (involved in neurotransmission and control of blood pressure and muscle function); creatinine (a byproduct of muscle metabolism); choline (used by neurotransmitters); and similar ingredients that target neurotransmitters, such as gamma-aminobutyric acid (GABA).

Other energy ingredients used in performance beverages rely on protein. These simply provide slow-release energy to run the body machine. The fourth category uses vitamins and vitamin-like compounds to charge the batteries. Finally are the drinks that rely on the apocryphal “sugar high” via sucrose, glucose, crystalline fructose or ribose. (From a metabolic chemistry standpoint, there is no true sugar “high,” in the ADD sense, but low blood sugar does cause a flagging of energy that can be revived with a sugar boost.)

The latest trends in energy drinks come out of the labs of nutraceutical scientists creating formulations that combine several or even all of these ingredients into sophisticated concoctions nearly as artful as the wild packaging these products tend to use.

X Marks the Spot

Caffeine and other xanthenes -- in fact most of the alkaloids and botanicals -- tend to be bitter. In coffee and tea, that bitterness is exaggerated by the tannins in those drinks. Yet, these ingredients can easily be incorporated into beverages without too much difficulty, due to the small amounts needed for them to be effective. Plus, neutral masking flavors can work quite well to counter the bitterness. They provide energy by acting as a stimulant to the heart (increasing heart rate) and a bronchodilator in the lungs, increasing oxygen intake. Xanthines also enhance the chemical reactions in the nervous system, as well as along the cellular energy production pathways.

Caffeine in energy drinks has experienced negative press of late, due to a number of reported overdoses, including fatal events -- specifically among young teens. But, the toxic dose is 10g (10,000mg), and even heavy consumers rarely exceed 500-1,000mg in an entire day. The severest effects of caffeine overdose are hard to reverse. However, the average 8oz caffeinated energy drink or 2oz caffeinated “shot” has only as much caffeine as a large cup of strong coffee.

Still, some formulators are increasing their efforts to create minimal caffeine or caffeine-free products.

“While caffeine seems to be an important ingredient, we strive to keep the per-serving level in our energy drinks below the 100mg/day maximum recommended for adolescents by the American Academy of Pediatrics,” says Linda Halik, director of R&D for United Citrus Products Corp. The company is a manufacturer and co-packer of beverage mix products and cocktail mixes, as well as sport and energy drinks.

“A similar course of moderation goes for the other energy drink components,” adds Halik. “With the American public subjected to all kinds of fortified foods and beverages consumed throughout a day, it seems prudent to not overdo vitamins and amino acids in energy beverages, either. Since there are no clear government guidelines as to the composition of energy drinks, and care must be taken to avoid making unsubstantiated claims, we follow a course of moderation in the addition of all energy components for energy drinks manufactured by the company, and this extends to contract development projects United Citrus does for other companies.”

Some evidence exists that non-caffeine alkaloids used in energy concoctions do not have the same negative side effects of nervousness, jitters, headaches, gastric irritation or coffee “crash.” Yerba maté has been shown to have different effects than straight caffeine on the nervous system, smooth muscle cells and cardiac muscle cells, and it has demonstrated ability to increase production of adenosine triphosphate (ATP), the universal energy currency of the body’s cells.

The Root of Energy

Ginger (*Zingiber officinale*) and ginseng (the *Panax* family of perennials) often are confused and even look vaguely similar, but they are botanically different. The former is a rhizome, and the latter a woody root. Ginger, subject of thousands of years of medical folklore and decades of scientific study, is credited with scores of systemic benefits, from anticarcinogenic, antimicrobial and anti-inflammatory actions to blood sugar management, serotonin uptake control and anti-diabetic abilities.

Ginger is known widely as a stimulant. Yet, in spite of this, ginger has been elusive in some ways to researchers attempting to describe the exact biochemical mechanisms of these reactions. Its main active compounds (dozens have been identified) are the methylated phenols zingerone, shogaols and gingerols.

Ginseng has a much stronger case as a stimulant that provides energy, at least based on tradition and preliminary research. Stimulant effects, ostensibly via its active compounds ginsenoside and eleutheroside, on blood pressure and the central nervous system have been documented, but have yet to be fully explained. It is similar in this respect to schisandra. Schisandra reportedly acts as an adaptogen on the cardiovascular, central nervous, endocrine and respiratory systems.

Antioxidants as a class are not typically known as stimulants, but many have been reported to have some sort of secondary “uplifting” effects anecdotally. It should also be noted that most of the botanicals mentioned as stimulants -- yerba maté especially -- are very high in antioxidant capacity. Interestingly, EGCG, from green tea, noted as a powerful antioxidant and anticarcinogen, has shown some success in studies on chronic fatigue syndrome. Of note to processors is that it survives processing conditions of high heat quite well.

Pro for Protein

The recent craze for protein has extended to its use as an energy ingredient. Protein as a significant source of calories has been shown to increase both satiety and metabolism. While the metabolic boost is a short-term reaction, as a “quick fix” typically sought by most energy beverage consumers, it has legitimate benefits.

Since protein is a fundamental nutrient necessary for building all muscle tissue, including, of course, heart and

vascular, it stands to reason that it eventually provides energy as both a caloric source in general and as a compensatory builder of tissues lost through wear and tear from daily, as well as concerted, exercise. Protein also is the building block for the enzymes responsible for running the entire machinery of the human body.

While soy and the dairy proteins whey and casein have been used in many energy bar formulations, only recently has the ingredient begun to find its place in clear beverages. This is in part due to the advent of ingredient technology that allows for clear, water-soluble encapsulated proteins, not only from soy, but also from peas, rice, potatoes, canola and other plants.

Clear proteins have excellent advantages for processors of energy and sport drinks, being functional in low and neutral pH with excellent solubility, clarity and a low viscosity. Their functionality in low pH makes them ideal for protein fortification of acidic fruit juices, juice blends and fortified waters. They also can be used to great effect and with high stability in powdered beverage mixes (their typical format being an odorless white powder). Being vegetable sourced, they can be marketed as vegan.

Drink Your Vitamins

There was a time in the 1970s and 1980s when vitamin B12 shots were all the rage, used to revive the hard-partying, burn-the-candle-at-both-ends members of the “Me Generation.”

The craze followed a landmark 1973 study in which B12 injections of 5mg (2,000 times the recommended daily needs) were given to 28 subjects in a double-blind crossover experiment. Subjects showed significant increases in mood, energy and sleep quality. Vitamin B12, also known as cobalamin, is needed in only very trace amounts -- 3µg/day -- and it has a short half-life at only a few days to a week. But cobalamin, directly or indirectly, is critical to the operation of every function of the body. Without it, bodies could not make DNA and, thus, could not make the proteins that form the enzymes. As previously noted, enzymes act as the drivers of every chemical reaction that keeps people alive.

Cobalamin is critical to energy production, as well as red blood cell formation. Red blood cells carry oxygen through the bloodstream, and it is through that mechanism B12 is thought to provide its fatigue-countering benefit. Subsequent studies have had mixed results as to whether cobalamin energizes in the same manner as caffeine, but it has extremely low toxicity and is included in energy beverages at levels of several hundred to several thousand times its recommended daily values.

Other B vitamins, including folate, pyridoxine (B6) and pantothenate (B5) also work to help the body generate energy. Pyridoxine, like cobalamin, helps the body with red blood cell production and thus oxygenation, and also is involved in neurotransmitter production and regulation. But, key to its use in energy products is its contribution to the enzymes that convert chemical precursors into adrenaline. Pantothenate is found in the muscle tissues of animals and humans and performs multiple metabolic roles, including biosynthesis of food energy; production of coenzyme A (needed for energy metabolism); and it's believed to boost the body's efficiency for using oxygen. It also has been shown to help counter the painful accumulation of lactic acid in muscles after a workout.

Coenzyme-Q10 is fast up-and-coming as a desired nutraceutical and deserves a place in the pantheon of power providers for its importance in generating ATP. (See “NutraSolutions: Next Generation Nutraceuticals,” PF July

2013.) In fact, nearly all of the energy production in the body relies on mechanisms that rely on CoQ-10, especially for the organs that use energy the most, such as the heart, and the organs most involved in metabolism (the liver and kidneys). Production of CoQ-10 drops off sharply once people hit their 30s. Formulators might have been reluctant to use CoQ-10 due to it being lipid-soluble, but advances in microencapsulation have made the co-vitamin available in water-soluble form for several years now.

Sweet Power

The classic energy source, of course, is sugar. As mentioned, the body and brain run on sugar. A drawback of many energy beverages is their use of simple sugars, sometimes in high amounts. (Some energy beverages currently marketed contain nearly ¼-cup sugar per 1-cup serving!)

One sugar stands out when it comes to providing healthful energy: ribose. Ribose is a 5-carbon sugar (pentose) that is a core component of RNA, as well as the B vitamin riboflavin (B2). Both of those compounds are needed to create ATP. In a study published in *Current Therapeutic Research*, scientists gave healthy, male recreational body-builders between 18-35 years old either a dextrose placebo or ribose (10g/day in powder formulation). The ribose-supplemented group experienced a significant before-and-after increase in the total work performed, whereas the placebo group did not change significantly. Also, the ribose-supplemented group experienced a significant increase in bench-press strength, whereas the placebo group did not change significantly.

Ribose also has been shown in studies to have other beneficial effects in boosting energy. It was found that the combination of ribose with reducing antioxidants could provide a more optimal state of cellular protection during and following times of oxidative stress. Also, ribose has demonstrated a beneficial trend in lowering toxic by-product levels during hypoxic stress of activity.

For processors, ribose has a distinct advantage in that it looks, tastes and performs like sucrose and is almost as sweet. Yet ribose, although it carries the potential to provide 4 calories per gram, has shown in some studies to count for about half of that or less. Still, it typically is declared as providing 4 calories -- the same as other carbohydrates.

Behind the Mask

The success of many energy beverages depends on masking the bitter, metallic or off-notes inherent in such potent ingredients as tannins, phytochemicals and botanical extracts.

Maskers might be necessary to counteract or erase the aftertaste of artificial sweeteners, vitamin and mineral premixes, proteins and strongly caffeinated formulations. In many cases, sweeteners and citrus flavors can suffice, but often sweeteners will overbalance a negative flavor that will then come through in the aftertaste, and can even enhance metallic flavors. Carbonation, too, is used to create an organoleptic mask of sorts, although it, too, can enhance the metallic notes from some stimulant compounds.

Antioxidants are good for masking some of these, such as vitamin mixtures, and various forms of vanilla extracts can be used to mask such off-flavors and aftertastes as those that come from plant proteins.

The astringency of citrus will effectively cut through an undesired flavor. However, it should be used in careful balance to avoid overpowering the palate or combining more strongly with bitter flavor notes to elicit a strong medicinal effect.

United Citrus' Halik points out, "The flavor profile of energy drinks in general is different from that of a refreshment beverage. Consumers seem to believe that if it tastes too good, it's not providing the energy components needed. In general, energy drinks have a heavier flavor and body compared to refreshment beverages. Some flavors are more conducive to covering the vitamin flavor and caffeine bitterness than others."

Halik notes that "complex, sweet, full-bodied flavors work best in energy drinks to cover the vitamin flavors and compliment the bitterness of caffeine."

She continues, "These would be flavors the public is not necessarily used to having a preconceived notion of what the declared taste should be."

United Citrus works with combinations of flavors, such as Mixed Jelly Beans or combined berry flavors or groupings of superfruit flavors, rather than delicate, light, traditionally crisp refreshment beverage flavors.

"The more non-descript flavors allow for some of the flavors and tastes of the functional ingredients to come through in an acceptable way," says Halik.

Energy Beverage Market

According to a recent study by the consumer research groups Business Insights and Mintel, energy drinks continue to show strong growth, with sales in the U.S. expected to double from 2009 figures by 2016. Retail sales of energy drinks, energy shots and energy drink mixes in the U.S. grew by 16% from 2011 to 2012, reaching nearly \$9.4 billion. Sales are forecasted to grow by 14% more in 2013. Business Insights further noted that B vitamins, especially B5, and caffeine were the most popular ingredients used in energy drinks in 2012. Caffeine still dominates the overall clinical trial landscape for energy drinks. B-vitamins, including B5 and B12, are among the most common ingredients found in patents that are relevant to energy-drink-related applications.

Source: Business Insights and Mintel

Know Your Energy

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With caffeine-charged beverages receiving a lot of negative attention in the past year, processors developing drinks for energy need to be up to date on both the technological challenges and the regulations surrounding the ingredients -- and amounts -- that go into popular liquid performance boosters

What products constitute “energy beverages” and which, including energy “shots,” are classified as “supplements?” Most energy drinks are regulated as beverages, but the difference between beverage and supplement is still a gray area.

In December 2009, FDA issued its draft guidance document, “Guidance for Industry: Factors that Distinguish Liquid Dietary Supplements from Beverages, Considerations Regarding Novel Ingredients, and Labeling for Beverages and Other Conventional Foods.” A long-winded title, but it addressed growing controversy over how companies were marketing beverages as supplements and vice versa -- products labeled as supplements marketed as beverages.

FDA determined that factors used to determine the status of a drink could include conventional terms like “water, “coffee” or “juice;” or using the word “beverage” or “drink” in the labeling, marketing and promoting of a dietary supplement. It also included the type, shape and size of packaging and recommendations as to serving sizes and daily intake as points in determining a product’s status. This meant the FDA could decide, based on the factors in these guidelines, whether a drink was a supplement or beverage -- regardless of the manufacturer’s designation -- and, thus, regulate it accordingly.

The functional ingredients used in an energy drink classified as a beverage must be approved as food additives or have GRAS status. Ginkgo, for example, is not an approved food additive or GRAS by regulation, and therefore, is not allowed to be included in a beverage unless a self-affirmed GRAS determination is made.

In 2012, FDA, in a response to Sen. Dick Durbin (D-IL), indicated that caffeine is generally considered safe at levels of up to 400mg/day for healthy adults.

However, caffeine’s GRAS status is defined by regulation as being allowed for use in “cola-like beverages” at a tolerance of .02%—or about 71mg per 12oz serving. This does not equate to a prohibition against using higher levels of caffeine. It does mean that a company using higher amounts of caffeine in beverages needs a “self-affirmed” GRAS determination, which it does not have to submit to FDA, in the event the FDA seeks evidence of GRAS status.

For more on the regulatory side, last month the Institute of Medicine in Washington D.C., held a workshop on The “Potential Health Hazards Associated with Consumption of Caffeine in Food and Dietary Supplements.” Conducted at the National Academy of Sciences, the meeting can be viewed by webcast and is described as “a two-day public workshop to discuss the potential health impacts stemming from the consumption of caffeine in dietary supplements and conventional foods, along or in combination with other substances found in products commonly referred to as ‘energy products.’” More information can be found at www.iom.edu.

For deeper technical information, a second workshop, “The Use and Biology of Energy Drinks: Current Knowledge and Critical Gaps,” was also held in August by the National Institutes of Health/Neuroscience Center Building, in order to “bring together and summarize relevant research on the use and biology of energy drinks and to highlight the most critical research gaps.” It also served to summarize research on patterns of energy drink use in the U.S., including population subgroups, such as young adults, children, minorities and the military; the safety of energy drinks and their ingredients; and the effects of energy drinks and their ingredients on alertness, fatigue, sleep, cognitive function and mental health, as well as physiological functions. Information on

that seminar is available at the NIH “news & events” page online at www.nih.gov.



David Feder, RDN, has been a food, nutrition and health journalist for 26 years. In spite of an academic background that began with psychology and biblical archaeology, David cut his teeth as a celebrated chef in Texas during the 1970s and 1980s, helping pioneer haute-health & fusion cuisines in high-end restaurants and hotels. In the 1990s he became a registered dietitian while completing research and coursework toward a Ph.D. in nutrition biochemistry at the University of Texas at Austin. Along the way he taught food science and nutrition while practicing as a nutrition counselor.