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DEEPDIVE REPORT

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Functional beverages driving global beverage innovation

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DEEPDIVE REPORT

Functional beverages driving global beverage innovation

by Cindy Hazen

Once dominated by sports drinks, today's functional beverage category includes everything from enhanced waters and cold-brew coffees to ready-to-drink (RTD) teas and juices. The biggest game changer, however, is consumers' thirst for clean label and reduced sugar options that not only taste good, but also deliver efficacious doses of active ingredients.

Beverages with benefits are in vogue as consumers turn away from carbonated soft drinks (CSDs) in favor of healthier options. Whether providing sparkling refreshment, plant-based protein, energy or botanicals, brands are challenged to develop innovative products with natural ingredients. Yet, it's not as simple as cutting sugar and adding milligrams of an herbal extract. Besides sweetness, sugar provides functionality. Natural ingredients often bring off-notes that must be addressed by use of masking flavors. And don't forget the product must be visually appealing as well as shelf stable.

Fortunately, developers can find the tools they need to get the job done. The range of functional, clean label solutions is as vast as the market opportunity.

Trends in sync

Proprietary consumer research conducted in 2017 by Cargill revealed most consumers (up to 77%) said they were extremely likely or likely to seek clean label products. "We also know products made with familiar ingredients are the top attribute associated with clean label," said Pam Stauffer, global marketing programs manager, Cargill.

But for consumers it's easier to describe what isn't clean label instead of what is. Cargill's research shed insight into their mindset. Consumers associated several attributes with an unclean label: chemical-sounding ingredients (55%), highly processed products (52%), anything containing artificial ingredients (45%), GMOs (44%) and artificial sweeteners (43%).

Sugar and protein content are two focus areas for many consumers. The 2019 International Food Information Council (IFIC) Food and Health Survey found 80% of respondents were trying to limit or avoid sugars in general, and nearly three-quarters of consumers rank protein from plant sources as healthy.[1] The survey also found little more than one-third of consumers view animal protein in the same light.

"Demand for protein-packed products has been part of the beverage landscape for a number of years, but what's new is how plant proteins are resonating with consumers," Stauffer noted.

In 2018, Cargill conducted a proprietary research survey, which included more than 1,900 U.S. grocery shoppers, to better understand perceptions of plant proteins. "In our survey, we found nearly half of respondents said they felt better about eating plant protein, and almost as many reported trying to eat more proteins from plants," Stauffer said.

While clean label, sugar reduction and plant protein are individual trends, Vince Cavallini, beverage, dairy and convenience foods application manager, Cargill, said there is increased interest in combinations of these trends.

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> —Pam Stauffer, global marketing programs manager, Cargill

"Whether they're formulating sparkling water or a dairy-replacement shake, it seems virtually every beverage maker is trying to reduce sugar," he said. "At the same time, there's a move toward cleaner, simpler labels and away from ingredients like artificial sweeteners. Plant-sourced proteins are in demand because consumers view them as healthful, familiar and sustainable—all critical points in today's marketplace."

Aligning with multiple trends presents the developer with a host of challenges. "For example, a customer who wants to create a reduced-sugar beverage might also tap into today's plant-based protein trend. Label concerns add a further layer of complexity, as they may want to avoid artificial sweeteners and certain texturizing solutions," Cavallini continued.

Besides these far-reaching trends, consumers are moving toward distinct beverage benefits. Jim Tonkin, founder and president, Healthy Brand Builders, pointed to increased use of pharma-grade ingredients in beverage formulations. These range from energy to brain

health to cardiovascular health. Consider the sports nutrition sector. Tonkin said beets, beet juice and beet powder are trending ingredients for increasing nitric oxide (NO), which improves blood flow to deliver more performance-enhancing oxygen and nutrients to the muscles.[2]

"There are also products coming to market that are really around condition-specific orientations," Tonkin said, noting the space for eGaming is a huge draw for beverages containing brain-supporting or energy-imparting ingredients. "eGamers are typically in their tweens or early 20s," he said. "It's a gigantic industry that still, frankly, is not being paid attention to by a lot of folks."

Several products being developed specifically for eGamers use either pharma-grade or dietary supplement ingredients that are focused directly on brain health. Getting the brain to focus, enhance hearing and promote eye health are marketable benefits. "All these ingredients are going to start focusing on this gaming community where the more focused and more fine-tuned their motor skills are, the better they can perform," Tonkin noted.

Market perspective

According to a proprietary 2018 Innova Market Insights survey, 3% of U.S. consumers said they've decreased their consumption of CSDs over the past year. "Carbonates are clearly the beverage category most affected by health concerns," said Tom Vierhile, vice president of strategic insights North America, Innova Market Insights. "Of consumers who say they have decreased their consumption of carbonated beverages, 70% say it is because these drinks are unhealthy. That said, innovation in carbonates is strong as drink makers introduce products positioned as more healthful than traditional carbonated soft drinks, and incumbents in the category move to defend their turf with flavor innovation."

Vierhile noted trending health claims during the comparison years. A look at the two one-year periods—one ending June 2019 versus the one ending June 2018, revealed growth in specific health claims in the U.S. beverage category.

Health claims on the rise

- ↑ 3.3% Sugar free
- ↑ 2.7% GMO-free
- ↑ 1.7% High/source of protein
- ↑ 0.9% Energy/alertness
- ↑ 0.7% Brain health
- ↑ 0.4% Skin health
- ↑ 0.4% Digestive/gut health

Source: Innova Market Insights

Of the top five fastest-growing beverage categories tracked by Innova in the 12 months ending June 30, 2019, two are intrinsically functional—energy drinks (up 63.2% compared to the 12-month period ending June 30, 2018) and RTD sports drinks (up 33.3%).

The report "U.S. Beverage Market Outlook 2019" by Packaged Facts provided further market insights.[3] "Both energy and sports drinks have been among the fastest-growing categories of the beverage market, seen as functional products with novel ingredients and healthier positioned alternatives to carbonated soft drinks. However, as more consumers have gravitated to better-for-you beverages, concern has increased over the use of artificial and potentially unsafe ingredients, as well as the sugar content of energy and sports drinks. Marketers have responded with more natural and organic products that have clean labels, reduced or no sugar, and ingredients that avoid the quick rush and subsequent quick crash of first-generation energy drinks. By cleaning up product formulations, energy and sports drink marketers are bringing in new users outside of their core consumer bases, and more effectively competing with growing beverage segments such as sparkling and functional water, and RTD coffee and tea."

Retail sales in the coffee and RTD category are projected to increase to nearly US$18 billion, according to the report. Sparkling and enhanced waters that provide benefits beyond flavor, vitamins and minerals also are expected to drive growth. According to Packaged Facts, next-generation product innovation opportunities are increased functionality (both performance and health related); customization through packaging and delivery systems; more plant-based innovations; continued blurring of water with other beverages; and emergence of CBD-infused waters.

Many of these market segments show solid potential in the next few years. According to 2019 data estimates from *Nutrition Business Journal* (NBJ), sales of functional beverages will increase to $62 billion by 2022, up from roughly $46 billion in 2018. Of that total, the soda, water and sports/energy drinks sector accounted for most of 2018 sales ($31 billion), followed by canned and bottled juice/RTDs ($7 billion). Interestingly, the frozen juice category saw a consistent drop in sales over the period, which could present opportunities for innovative functional juices in the frozen aisle.

Projected 2022 U.S. functional beverage sales by category

$9 billion
Canned and bottled juice/RTDs

$2.1 billion
Dairy alternatives

$60 million
Frozen juice

$3.86 billion
Refrigerated fresh juice

$44 billion
Soda, water & sports/energy drinks

$2.8 billion
Tea, coffee & cocoa

Source: Nutrition Business Journal

Sustainability resonates with consumers

Consumers also have a strong interest in eco-conscious and sustainable packaging and are pushing back on plastic bottles, which creates opportunity for less expensive, lightweight alternatives. “That orientation is really hitting very strong to particularly the younger generation, Gen Z, Gen Y and anyone under age 35,” Vierhile said. “They’re all about sustainability. They’ve grown up understanding the issues about pollution. They’ve seen it firsthand at the ocean and on beaches. They’ve heard it in the news forever. Culturally, we’re moving toward a big sea change in the world of sustainability, particularly around packaging.”

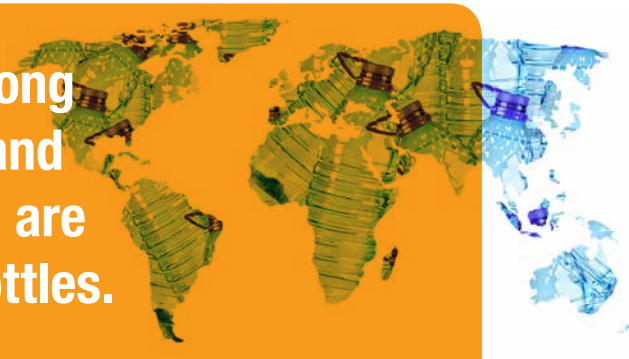
Because aluminum is 100% recyclable, cans are a viable option. Aluminum bottles are another sensible choice. If the consumer can reuse them, it’s another marketing win.

Tetra Pak and Combibloc are partially recyclable. “They’re a good alternative as well, to plastic, Tonkin explained, “but they’re not quite there. I think less is more in packaging, and I think we’re starting to finally get that.”

As consumers seek to learn more about the products, they are diving deeper than the outer packaging and the ingredient statement. The IFIC survey found half of consumers said knowing where their food comes from is highly important, and nearly half said a manufacturer’s commitment to environmental sustainability was a key consideration.

Sustainability is one reason Cargill turned to fermentation to produce EverSweet stevia sweetener. Reb M and Reb D exist in the stevia leaf in such low levels that it’s not economically or commercially viable to produce a sweetener made from Reb M and Reb D using a traditional approach. “From a sustainability standpoint, we would need significantly more water and land, and have a much higher carbon footprint,” said Andy Ohmes, global director of high-intensity sweeteners, Cargill. “Through fermentation, we can provide our customers with a scalable product that delivers the same great taste, but in a sustainable way.”

“Consumers also have a strong interest in eco-conscious and sustainable packaging and are pushing back on plastic bottles.”



Sustainability and environmental stewardship are especially important when the product is plant-based. “Many botanicals are wildcrafted, meaning the plants are collected or foraged from natural habitats as opposed to being planted and cultivated on a farm,” said Rikka Cornelia, product manager, BI Nutraceuticals. “In these cases, it is essential to work with a reputable supplier that has direct knowledge about where and how these ingredients are collected so the correct plant is not only identified, but also collected in a sustainable manner.”

The supply chain partner is also critical when sourcing non-GMO ingredients. Buyers must ensure suppliers are able to deliver high-quality, consistent ingredients at a reasonable cost.

Tonkin cautioned that anything grown from Mother Earth has sustainability aspects associated with it because the world only has so many growing regions. When ingredient use becomes large scale, supply may be short. Case in point: CBD, as skyrocketing popularity means it's outstripping the ability to grow enough. Until the passage of the 2018 Farm Bill, hemp was not allowed to be grown in the United States, so it was sourced from Canada and other geographies. "Now, there's a huge run to be able to plant hemp in the United States to fill the impending CBD and cannabis run that consumers seem to be running toward," Tonkin said.

Organic is on trend too, but it takes a minimum of three years to covert conventional soil to certified organic. "You can't grow anything there for that period of time," Tonkin said. "The soil has to be turned. You must confirm there is no residue of pesticides or anything else that would negate an organic certification. There are some gatekeeper issues that have to do with supply chain and sustainability. But in the end, consumers are going to tell us what they're interested in, and that's what's going to refocus the entire farming industry. Farmers grow what's needed, and that's typically the way. It's a supply/demand situation."

Sweetening solutions

People love the taste of sugar, but as consumers turn their attention to health, they are cutting back and seeking natural solutions. In functional beverages, sugar plays a larger role than adding sweetness. Joe Farinella, vice president of product development, Imbibe, called sugar the world's best masking flavor. "Adding a little bit of sweetness helps round out off-notes from botanicals, vitamins, minerals and plant-based proteins," he said.

When developing a reduced-sugar or sugar-free beverage, a 1:1 sugar replacement is virtually impossible, so a sweetening system of two or more sweeteners is necessary to bring balance and contribute notes lacking in the other.

Stevia is a popular option for sugar reduction. Besides being plant-derived, it has zero calories. But it has limitations. "When used alone, stevia can only go so far—it has a sugar equivalent value (SEV) of 8," said Wade Schmelzer, principal food scientist, Cargill. "For applications like diet colas and sweet teas, which often have a 10 to 12 SEV, stevia alone won't provide all the sweetness intensity consumers expect. However, by blending stevia with erythritol, we get more upfront sweetness, enabling deeper sugar reductions. Small amounts of erythritol, at low levels below sweetener thresholds, can help round out the sweetness profile and, at the same

time, enhance other flavors in the formulation. Other alternatives include pairing stevia with monk fruit or using flavor modifiers to give an extra boost of sweetness."

Early generation, high-purity rebaudioside A (Reb A) stevia products have a place in beverage reformulation efforts. Cargill's first stevia product, Truvia, can be effectively used to replace up to 30% of the sugar in a beverage depending on the application. ViaTech, launched in 2014, provides more versatility in reformulation and allows for sugar reductions of up to 70% in a wide range of applications. The company's Eversweet allows up to 100% sugar replacement through a combination of Reb M and Reb D that provides greater sweetness intensity and a more rounded, sugar-like flavor.

How best to leverage stevia in an application is really driven by a brand's identity and the taste expectations of its core consumers. Sugar reduction for an existing brand may require coupling stevia with erythritol or another sweetener to match the existing flavor, while a new beverage has more flexibility in development. "The overall sweetness intensity to be delivered by stevia and complementary sweeteners is also critical in determining the best approach in development," Schmelzer advised. "Replacement of 3% to 4% sucrose can be achieved using stevia alone, while upwards of 10% sucrose sweetness will likely involve coupling with other sweeteners or flavor tools."

In exploring sugar reduction in acidified applications such as juices, the marriage of sweetness and sourness is crucial. Next-generation stevia sweeteners products have focused on improving sweetness dynamics to help deliver sweetness at the right time, in concert with the acid, to ensure the most robust flavor impact. Other sweeteners, such as erythritol, can be useful in helping to round out the overall sweetness profile.

Thom King, president, ICON Foods, agreed that erythritol and stevia blends are solid in all the functional beverage categories. "But the erythritol and monk fruit blend is gaining traction, and so is the allulose, stevia and monk fruit blend. The allulose, stevia and monk fruit blend participate in lactobacillus fermentation, making it perfect for a low-sugar fermented drink of any kind." A blend of allulose, stevia and monk fruit, dubbed CannaSweet by the company, is designed for use in CBD beverages.

ICON Foods' RA99 stevia and RA99M (a glycoside blend) or mogroside V 50 also work well for lightly sweetened beverages that don't require a sweetener to contribute to mouthfeel. "These all work very well in percentages below 0.025," he noted.

Allulose, stevia and monk fruit also present clean label options. However, King noted when used alone, natural high-intensity sweeteners such as monk fruit and stevia can contribute off-notes. Combining the two conveys a masking effect, but not completely. Adding erythritol contributes a cooling effect. “This can be offset with inulin,” he said. “Allulose has very little if any after taste. It does activate yeast, so fermented beverage makers should consider this to avoid secondary bottle fermentation.”

While monk fruit offers clean label appeal, cost is a consideration. “Appropriate flavor pairings help to make a better end product, but pricing and supply stability have a significant impact when attempting to scale from the lab to retail volumes,” said Alex Holste, commercial manager–stevia, monk fruit, erythritol, Archer Daniels Midland Co. (ADM).

Building and maintaining body

Removing or reducing a multifunctional ingredient like sugar brings new challenges to the mix. The developer might achieve the desired sweetness using high-intensity natural sweeteners, but may find the mouthfeel is lacking. Bulk and density can be replaced using a texturant system. Pectin is a popular choice. Recognizable and familiar to consumers, it replaces the body, texture and mouthfeel of sugar, allowing formulators to replicate sugar’s feeling on the tongue.

Lisa Bradford, senior scientist–applications science and technology, ADM, said ingredients such as soluble corn fiber, mouthfeel enhancers and texturants can be used to provide mouthfeel. Depending on the formulation, a variety of ingredients can achieve the finished product attributes.

“Erythritol is another option,” Cavallini said. “It not only provides additional sweetness and rounds out the flavor profile of high-intensity sweeteners like stevia, it also can help replace some of sugar’s bulk for improved mouthfeel.”

Reducing sugar in juices creates deeper problems. Orange juice, for example, is a combination of water and orange oil, pulp and protein. In a regular orange juice, those components stay together because of the liquid’s density. Reduce the sugar, and the pulp and protein precipitate out, leaving the water on top. Hydrocolloids such as pectin can help keep all those components in suspension.

Low-pH beverages have different issues. “Popular beverages like drinkable yogurts, milk-juice blends and other low-pH dairy drinks wouldn’t exist without today’s improved pectins,” said Wen J. Shieh, Ph.D., technical leader–fruit, beverage and confections, Cargill Texturizing Solutions. “In low-pH protein-fortified beverage applications, pectin helps to stabilize the proteins, preventing them from breaking down. Without pectin, the proteins begin to stick together, forming large clumps that settle to the bottom of the container, producing a low-quality product. This also causes the gritty texture sometimes present in low pH protein beverages.”

Bulking up with fiber

Besides adding a healthy halo, adding fiber can influence sweetness and texture. Chicory root, the main source of inulin, is in step with today's clean label trends. Developers will find it easy to use since it's highly soluble and has a neutral taste. It's best used in neutral pH beverages because, according to Cavallini, "It tends to reduce to simple sugars in high acid, low-pH products (pH 4.0 and lower) and is usually not recommended for these applications."

While inclusion rates vary based on the desired claim, beverages may contain 3 to 5 g of chicory root fiber. It's often used as a prebiotic to promote digestive health. "In the beverage space, we're starting to see innovative formulators pair probiotic and prebiotic ingredients," said Taylor Halstead, product manager of specialty carbohydrates, Cargill. "While consumer understanding of the role that prebiotics and probiotics play in overall health and wellness is still in its infancy, we believe opportunities in this space will grow. Already, we see indications of increased awareness."

Depending on the grade, chicory root fiber may add little to no viscosity. King said it works particularly well in more opaque beverages such as dairy, protein drinks and smoothies. "FDA considers chicory root fibers the only naturally derived fiber that can garner a fiber count on the Nutrition Facts label," King noted.

Beyond digestive benefits, fibers can contribute many functions, depending on the fiber type. "Fiber can add viscosity and mouthfeel to products such as RTD smoothies, sports performance drinks, meal replacement shakes and drink mixes," Cornelia said. "For example, a fiber-rich ingredient such as psyllium, which has a great balance of both insoluble and soluble fiber, tends to thicken when in the presence of liquid to help add mouthfeel to beverages, especially diet shakes that may be lower in fat. Psyllium's ability to enhance mouthfeel can help low-fat diet shakes seem creamier and more indulgent without added fat, while simultaneously providing dietary fiber, resulting in a double benefit from both a formulator and consumer standpoint."

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>
> —Thom King, president, ICON Foods

Cornelia said the best approach when working with fibers is to start with the highest level desired from a marketing standpoint and evaluate its feasibility with the product or if a reduction is necessary. "Also, pay attention to the order of incorporation of different ingredients when working with fibers. The order can sometimes affect how the fiber interacts with the other components, which can then be adjusted to provide the optimal finished product," she cautioned.

As with any ingredient, its effect on taste and texture should be considered. “In some cases, fibers can be highly water soluble and almost unnoticeable when added to a light beverage, like a flavored water or tea. In other cases, fibers increase viscosity or retain moisture, which can help with an enjoyable mouthfeel,” Cornelia added. “If it has the opposite effect, formulators can modify or remove other ingredients for a more appealing texture. When it comes to taste, fibers do not typically affect flavor as much as other functional ingredients like proteins.”

Ingredients for immune health

Probiotics play a role in keeping us well. It’s been estimated there are as many as 100 trillion bacteria in our intestines. The ways in which they colonize, and the roles of each, create a delicate balance. Adding beneficial bacteria to our diets helps keep the bad bacteria at bay. Beyond digestive benefits, a healthy gut is linked to immune, heart and brain health.[4]

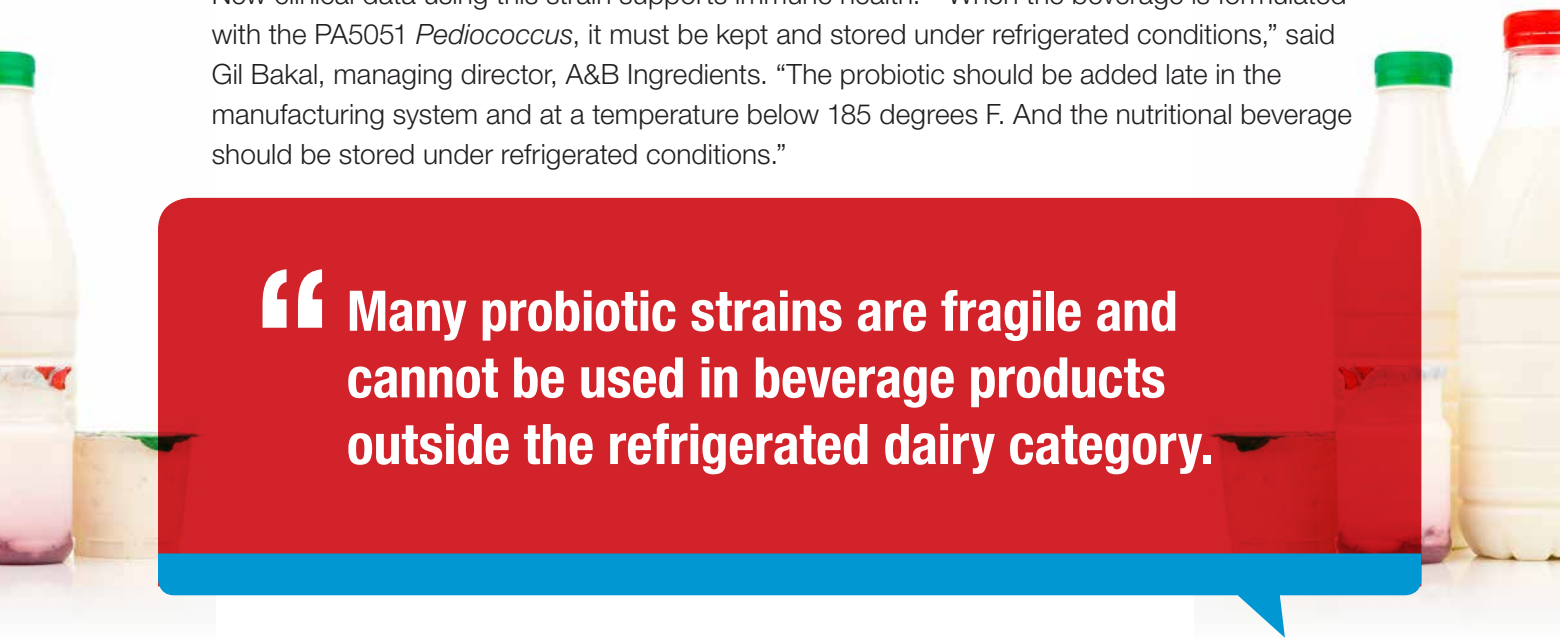
But there’s a trick. The World Health Organization (WHO) defined probiotics as “live microorganisms that when administered in adequate amounts, confer a health benefit on the host.” Many probiotic strains are fragile and cannot be used in beverage products outside the refrigerated dairy category. Processing and shelf life can be deadly to microorganisms, but their survival is essential for them to be a probiotic.

Bacillus coagulans probiotic strains are spore-formers. They are hardy, with a structure that is much more resistant to the extremes of pH, heat, cold and pressure than the widely used *Lactobacillus* and *Bifidobacteria* strains. GanedenBC30 (*Bacillus coagulans* GBI-30, 6086), from Kerry, is a patented strain with a protective shell that shields it from both stomach acids and a range of conditions common to beverage production, including HTST (high temperature/short time) and HPP (high-pressure processing) pasteurization, boiling and freezing. It survives gastric acidity and has a shelf life of up to three years.

“Because GanedenBC30 can survive almost any manufacturing process, it can be used in many beverage categories,” said Donald Cox, Ph.D., director of research and development, Kerry. “From hot teas and coffees to powdered mix-ins and HPP juices, the possibilities are virtually endless. Some of our partners have even developed straws and cap technologies that allow probiotics to be formulated in the shelf-stable beverage category. One of the few formulation challenges is in shelf-stable beverages, but our partners have found solutions through cap dispensers and straw technologies.”

Inclusion levels depend on the survival rate of the probiotics and post-processing at the end of a product. Generally, Cox said inclusion ranges from several hundred million CFU per serving to 2 billion CFU per serving. “Further, the inclusion rate of probiotics is strain specific and must be supported by research validating these amounts. The inclusion rate of one probiotic strain is likely different than another similar strain. The benefits of GanedenBC30 are now supported by more than 27 published studies that demonstrate its positive effects on digestive health as well as immune health and protein utilization support.”[5]

A&B Ingredients offers a plant-based probiotic that is based on *Pediococcus acidillactici*. New clinical data using this strain supports immune health.[6] “When the beverage is formulated with the PA5051 *Pediococcus*, it must be kept and stored under refrigerated conditions,” said Gil Bakal, managing director, A&B Ingredients. “The probiotic should be added late in the manufacturing system and at a temperature below 185 degrees F. And the nutritional beverage should be stored under refrigerated conditions.”



> **“Many probiotic strains are fragile and cannot be used in beverage products outside the refrigerated dairy category.**

Wellmune, Kerry’s proprietary baker’s yeast beta 1,3/1,6 glucan, is supported by more than a dozen clinical studies that demonstrate its ability to support the immune system, Cox said.[7] “They demonstrate its ability to support overall immune function, help maintain overall physical health, protect against the harmful effects of stress, and to promote healthy energy levels and mental clarity.”

An efficacious daily serving varies based on age and weight. Wellmune’s clinical research supports a recommended serving of 250 mg per day for adults and 35 mg to 100 mg for children, depending on age, Cox said.

Partly because immune health is sought after by consumers in every demographic group, Wellmune works well in a wide range of beverage categories. “For example, it is an excellent addition to juices targeted at children, where it can provide a ‘halo polish’ to a category that lost some of its reputation due to high sugar content and consumer drive for sugar reduction,” he commented.

It is also perfect for sports nutrition beverages, where it can help meet the growing demand for immune health benefits among both serious athletes and weekend warriors. “In a recent study, marathon runners consuming a beverage containing Wellmune saw a 19% reduction in the severity of URTIs [upper respiratory tract infections] compared to a placebo group,” he

continued. “They also missed fewer post-marathon workouts and enjoyed a 10% decrease in total symptomatic days. And previous clinical research found that marathon runners taking Wellmune experienced a 22% increase in vigor and a 48% reduction in fatigue.”[8]

Dairy proteins still in demand

Consumers can’t get enough protein. It’s the one component of food that has consistently had a stellar reputation, and as consumers associate protein with lean body mass and satiety benefits, the demand for protein will continue.

Because whey protein contains branched chain amino acids (BCAAs), it’s recognized for building muscle mass. “Whey protein is the only protein that has a protein digestibility-corrected amino acid score (PDCAAS) of 1—which is the most complete protein based on protein digestibility,” said Nicole Mueller, sales and marketing manager, Grande Custom Ingredients. The PDCAAS is a method of evaluating the quality of a protein based on both the amino acid requirements of humans and their ability to digest it.

Hydrolyzed whey protein isolates have undergone an additional process called hydrolysis to partially break down the protein, accelerate digestion and increase the number of peptides. Hydrolyzed whey facilitates a more rapid absorption of amino acids for a superior anabolic stimulus and may also enhance fat burning. Additionally, studies show that a high protein breakfast that includes high-protein milk that is fortified with higher levels of whey reduces the risk of obesity and type 2 diabetes.[9]

When creating a protein-fortified beverage, the first step is to determine the protein target. Consider the product’s appearance. The choice of whey protein will determine whether the product will be translucent or opaque. Similarly, the choice may change depending on the application such as a dry mix or RTD.

Pay attention to pH. “Whey proteins aren’t stable when they are close to their isoelectric point of 5.2,” said Sara Menard, technical sales manager, Grande Custom Ingredients. “Formulating around this pH is critical and a stabilizer could be necessary if you are too close to the isoelectric point. A lot of citrus flavored protein drinks are formulated close to 3.5 causing astringency.”

The developer must also be aware of how ingredients play together. Most fruit juices, water, dairy milk, plant or nut milk work as carriers for whey protein beverage formulations. However, Menard cautioned cranberry fruit juice doesn't work well with whey protein because the tannins fall out, creating sedimentation. The same is true for teas. Suspension challenges also can occur due to ingredient interactions, and a stabilizer may be necessary. "One we often use successfully is low methoxyl pectin due to its stabilization of calcium-based ingredient," Menard said.

Whey proteins work well under different processing systems such as ultra-high temperature processing (UHT), aseptic, HTST, retort and plate exchange heaters. To perform well, whey proteins need to be hydrated before heating. They could clump if added to a hot beverage.

Brands looking to create a yogurt flavored protein drink can turn to high-protein Greek yogurt powders such as Primo G60 from Grande Custom Ingredients. The yogurt powder contains 60% protein and allows a Greek yogurt claim on the label.

"We have seen successful formulations of 15 g of protein per 8-oz. serving or protein as 10% of the formula," Mueller said. "One thing you want to keep in mind when formulating with whey proteins, is that you need to formulate at a pH less than 3.5. Formulating at higher pH's at or near the pH of whey protein will cause aggregation and precipitation of the proteins."

Plant proteins in the spotlight

For years, soy led the way in beverage formulations. Aside from being a complete protein suitable for all demographics, soy isoflavones can help alleviate symptoms associated with menopause such as decreasing the frequency and intensity of hot flashes.[10]

Soy can be used in a variety of beverage applications including powdered and RTD meal replacements, milk alternatives and low pH beverage systems. Soy also can be used in drinkable yogurt alternatives and used synergistically with a variety of other proteins.

As with whey protein, imitations exist in low pH beverage systems. "The recommended protein content ranges from 1% to 3% as the protein is being exposed to conditions near the isoelectric point," Bradford advised. "The best formulation option is a soy protein which exhibits low functionality."

Not so long ago, soy was the only plant protein used in beverage formulation, but now product developers have an array of options, including pea, rice, chickpea and even pumpkin.

Not so long ago, soy was the only plant protein used in beverage formulation, but now product developers have an array of options:

Pea

Rice

Chickpea

Pumpkin

Pea protein is particularly well-suited for beverage applications. “Cargill offers PURIS Pea 870 H, a mildly hydrolyzed pea protein that delivers 80% protein, yet features low viscosity and optimum solubility, making it the perfect choice for RTD beverages and dry beverage blends,” Cavallini said. This pea protein is sourced from non-GMO yellow pea seed varieties specially selected to minimize the off-flavors normally attributed to pulses.”

“Formulators should keep in mind that pea protein is not a complete protein as two of the amino acids, methionine and cysteine, are limiting,” Cavallini continued. “However, it’s easy to compensate by either blending pea protein with a complementary protein source like rice or adding extra pea protein to achieve the target protein claim.” It’s important to note that not all pea proteins are the same, and even plant proteins with the same botanical source can have very different flavor profiles.

In addition to flavor, solubility is another consideration, especially in higher-protein beverages. Pea protein is more soluble than most botanical proteins, making it easier to keep in suspension. It’s especially well-suited for both neutral and low-pH beverage applications. Neutral pH beverages typically have a pH of 7, far above pea protein’s isoelectric point, which ranges from 4.5 to 5. The farther a beverage’s pH is from a protein’s isoelectric point, the easier it is to keep the protein in suspension.

> **“It’s important to note that not all pea proteins are the same, and even plant proteins with the same botanical source can have very different flavor profiles.**

Low-pH applications such as smoothie-style beverages with some fruit in the mix present a few more technical challenges. “In these acidic applications, pH levels are much closer to the isoelectric point of pea protein, causing the protein to precipitate out of solution. To protect the proteins and keep them in suspension, we often turn to hydrocolloids like pectin. We offer pectins specifically designed to surround protein molecules, preventing them from breaking down and keeping them in solution. Gellan gum or carrageenan can also help maintain mouthfeel and prevent protein sedimentation throughout the product’s shelf life,” said Melissa Machen, senior technical services specialist, plant protein, Cargill.

Although pea proteins may be soluble, they have low wettability. “They require shear to be well dispersed. Solubility of many pea proteins can be improved with homogenization and thermal treatment,” Bakal said. To improve the solubility of pea protein in acidified beverages and to reduce the amounts of sediment, he advised utilizing a homogenization and thermal treatment to the pea protein in solution and then use that as a basis for the rest of the formula. If hydrocolloids are used, add them after the pea protein is hydrated.

Also beware that soluble calcium salt may precipitate pea protein and result in a beverage with high sedimentation. When working with pea protein isolate, Bakal advised using insoluble calcium and to stabilize it with carragenen and CMC or cellulose gel/cellulose gum combinations. Soluble magnesium also will precipitate pea protein. “In this case thermal treatment and homogenization are recommended to reduce the level of sedimentation,” he said.

Cornelia said the biggest hurdle for proteins is use level. “Manufacturers want to pack their product with as much protein as they can, but as use level increases so do taste and texture challenges,” she said, noting proteins often have off-notes or texture issues that need to be resolved. “This is particularly true for plant-based proteins, which even in their highly concentrated form may contain plant starches that can affect overall texture. Dairy-based beverages, especially smoothies, are the most popular candidates for protein fortification since they have a thicker consistency ideal for protein powders.”

Just like with fiber, Cornelia said formulators should determine the desired protein level or claim from a marketing standpoint (i.e., if 10 g of protein per serving is desired or an “excellent source” claim). With this approach, it’s important to start with the highest level desired and can evaluate if it is feasible with the product or if a reduction is necessary, she noted.

The potential of botanicals

In addition to clean label, botanicals can add functional, nutritional and/or product development attributes such as color and flavor to beverages. But with so many botanicals available to the developer, it is difficult to lend specific considerations.

“A general rule of thumb for any type of product development can be applied to formulations using botanicals,” Cornelia said. “Because different ingredients will affect the flavor, texture and even the shelf life of a beverage, it is best to work with knowledgeable suppliers that can help formulators navigate ingredient variance and characteristics.”

Certain botanicals provide a positive flavor while others contribute bitterness, especially those that contain caffeine. “Ultimately, formulation depends on what the intended consumer experience is,” Cornelia added. “It’s important to keep consumer preference and trends in mind. Right now, we are seeing the beverage market shy away from over-the-top sweetness, and embracing bitter and sour notes. The explosive growth in cold-brew coffee and kombucha speak to this change in consumer preference.”

Botanicals can be incorporated in almost any type of beverage, but as with all new developments, the intended finished application can help guide the formulator as to which form and use level will be best. Consider ginger. “In flavored water, a ginger extract at a low-use level might be the best fit due to solubility and flavor impact; however, in a black tea where a stronger flavor is desired, a juice concentrate or whole root powder might be a better fit,” Cornelia said. “In other cases, botanicals are not as flexible as ginger and are limited to specific applications.”

Certain botanicals are becoming popular in beverage applications. Adaptogens such as ashwagandha and turmeric increasingly being found in coffee and dairy-based and dairy alternative drinks, while CBD and hemp are appearing in protein drinks and sparkling water. Fermented ingredients, including apple cider vinegar and kombucha, are being incorporated in teas, while flowers such as hibiscus and lavender are found in alcohol and RTD teas.

“Mushrooms, such as chaga and reishi, are being included in coffee, dairy-based and dairy alternative drinks, and teas,” Cornelia added, noting nootropics, such as ginkgo and rhodiola, are making inroads in energy drinks. “Plant-based proteins, such as pea protein and pumpkin seed protein are being incorporated into coffee, dairy-based and dairy alternative drinks, and protein drinks. Spices—cinnamon and ginger, for example—are being formulated in kombucha and other fermented drinks and RTD teas. Teas, of course, might bring in matcha and purple tea.”

Tonkin said there’s been an uptick in the number of water brands incorporating botanicals into their beverages. He added some companies are using derivative flower components to impart physical aspects of the human condition. As an example, “If you drink this one made from a specific flower found in Australia, it helps you to focus. Or it helps you to relax. Whether they do or they don’t is a very subjective thing, and consumers will try these things and if they find that they work, that’s great,” he said.

Energy ingredients

B vitamins are currently some of the most popular ingredients due to their association with increased energy.[11] Processing and shelf life can significantly affect vitamin and mineral levels, so it is important to understand their limitations in order to include overages, so the vitamin and mineral label claim are accurate until the end of shelf life.

Vitamin B1 can give sulfur off-notes, while iron and potassium may give bitter, metallic aftertastes. It may be useful to bring in a masking agent or additional flavorings.

Caffeine is the most popular ingredient for adding energy.[12] The coffee bean is the gold standard; however, a few other plant ingredients contain caffeine such as guarana, guayusa and kola nut. Ginseng does not contain caffeine, yet it also enhances energy.[13]

Many consumers start their day with a cup or two of coffee, providing fuel throughout the day. “The coffee space is continuing to grow,” Tonkin said. “Cold-brew coffee is taking hold in the market. There’s a lot of competition and still a lot of growth. So, I think consumers are still opting into it and aren’t tired of it as coffee continues to morph.”

Yet, he sees a downside to the drive for more energy. As we get faster as a society, we are living on social media. Our brain is engaged all the time. “We’re going, going, going, and the antithesis of that has got to be sought after,” he said. “Which means how do you disengage? How do you relax? Many people are having a hard time sleeping. Not just the older, aged folks in our culture, but a lot of young people can’t sleep well because they’re so attuned to their phones, their iPads and their computers.”

CBD’s time to shine?

Many consumers who are having a hard time slowing down are looking for relief. That’s where CBD comes into the picture. A derivative compound from hemp, it’s touted as having numerous benefits ranging from reduced anxiety, help with sleep issues, stress relief and pain management.

Yet, there is no authority on CBD. “There’s no efficacious platform,” Tonkin said. “The government hasn’t weighed in on efficacy, safety standards, supply chain verification and all those kinds of things.” Moreover, FDA maintains CBD products are still subject to the same laws and requirements as FDA-regulated products that contain any other substance. FDA has approved one prescription drug product to treat a form of epilepsy. No other CBD products have been approved. “There is very limited available information about CBD, including its effects on the body,” the agency wrote on July 17, 2019.

A great unknown is the potential for toxicity over long term use. “During its review of the marketing application for Epidiolex—a purified form of CBD from GW Pharmaceuticals that FDA approved in 2018 for use in the treatment of certain seizure disorders—the agency identified certain safety risks, including the potential for liver injury. These are serious risks that can be managed when an FDA-approved CBD drug product is taken under medical supervision, but it is less clear how these risks might be managed when CBD is used far more widely, without medical supervision and not in accordance with FDA-approved labeling,” FDA stated.

Another unanswered question is the effect of cumulative exposure to CBD if people access it across a broad range of consumer products. “For example, what happens if you eat food with CBD in it, use CBD-infused skin cream and take other CBD-based products on the same day? What if you use these products daily for a week or a month?” FDA stated. The agency also is concerned about the effects of CBD on special populations such as the elderly, children, adolescents, pregnant and lactating women.

FDA is calling out companies marketing products with unproven medical claims. For example, on July 22, 2019, the agency issued a warning letter to Curaleaf Inc.

Aside from regulatory issues, CBD has peculiarities that make its incorporation into beverages difficult. “From a purely technical standpoint, like any oil or fats, CBD is hydrophobic. It does not inherently want to go into a beverage,” Farinella said. Emulsifiers can be used to create a water-stable version. Microencapsulation is another option.

When working with emulsifiers, he cautioned to be mindful of the density of the beverage and to make sure the oil phase is weighted properly so that it's going to be stable long-term. "There are a number of ingredients we've come across that claim to be water soluble and are not. But there's a couple that are inherently. Do your homework." He recommended bringing in a lot of different ingredient options from different suppliers and then do some screening work to find the ones that are going to work best in the application.

Taste is another challenge CBD brings to the product. Farinella said some sources are very clean, but others, particularly the hemp-derived, have a lot of negative taste elements that must be masked. Often, suppliers don't do much outside of extracting the oil, which is why he stressed the importance of getting different ingredients from different suppliers to determine what works.

Formulation advice

With countless ingredients at hand and a wide range of product parameters, it is critical for product developers to have a clear understanding of exactly what the customer desires as the finished product.

For example, it's not enough to envision a lightly sweetened energy drink that's fruit flavored and provides a good level of boost. "You have to get really granular," Farinella stressed. "What's the maximum level of calories you're willing to live with? What's the maximum amount of added sugar you're willing to live with? Are you comfortable with natural sweeteners only, and if so, is stevia okay?"

It comes down to not only getting all the details, "but also gaining an understanding of the truly critical, must-haves from a customer and then what are the nice-to-haves and what are the areas where there is some wiggle room to just to make the product that much better," he continued.

For example, low-acid protein beverages and retorted coffee beverages are some of the most difficult beverage applications. Straight coffee is not a challenge, but adding protein—from plants or dairy—adds complexity that is not easily managed.

"That goes for the low-acid protein drinks as well," Farinella continued. "Often, these beverages have other ingredients that can present some off-notes. Those challenges exist in dairy, but there are a lot of flavor and ingredient solutions that can be used to mask."

On the plant protein side, off-notes can make it challenging to achieve the desired taste profile. "Coffee on its own has a bitterness and astringency that some coffee drinkers love, but from a mass-market point, generally you want something that tastes indulgent and sweet," he said.

Product stability is another often overlooked area, which is why shelf-life testing throughout the development process is critical. "It's very different to mix ingredients on the bench, and perhaps even go through a small-scale thermal processor," he added. "The product might look good after day one or even a week, but it's a different scenario to achieve a homogeneous product that's stable with the protein in suspension for nine to 12 months."

Imbibe has methodologies around particle size analysis to give early indications of stabilities of beverages that contain emulsions and/or protein. “Proteins are generally very complicated molecules,” Farinella said. “They have elements that are hydrophobic and don’t want to be in solution, so generally you have to add different gums and stabilizers that are going to cover up those hydrophobic parts, and ensure the different protein molecules aren’t coming together and forming larger structures and then falling out of solution. So, that stabilization piece, just from a pure chemistry standpoint is difficult. There’s definitely an art to it.”

He cautioned it may take a couple of rounds in the pilot plant to get to a stable base formulation before moving on to formula optimization such as flavor and color. “Once you get a formula on the bench or even in the pilot plant that a customer approves, you’re pretty much only halfway done,” he cautioned. “The product must survive the full manufacturing process—whether it’s a UHT aseptic, low-acid product or a retorted product. The processes to manufacture coffee and dairy or coffee and plant protein drinks are just very abusive.”

For example, UHT processing involves temperatures of 280 to 300 degrees F for three to six seconds, while retort processing involves holding a product at a lower temperature of 250 degrees F for 10 to 20 minutes. “You’re already dealing with a pretty delicate system, and you’re subjecting the proteins, gums and hydrocolloids to extreme temperature conditions,” he said.

“It’s one thing to make a product stable at one gallon a minute through a small benchtop processor, but it’s a whole other ball game when you’re doing 60 gallons a minute and there is more physical, shear abuse on the product that could break up those delicate structures that you spent so long trying to create,” Farinella continued. “So, it’s commonplace to have a formula work at small-scale, and then you go to an intermediate pilot plant scale or even production scale, and that exact same formula will not be stable because of the increase in abusive conditions that it sees.”

The last sip

Consumers' thirst for functional beverages demands more from product developers. Clean label adds another challenge. The market requires brands to meet evolving essential attributes such as reduced sugar, use of natural ingredients, increased protein, and inclusion of ingredients that impart targeted benefits while at the same time, delivering beverages that appeal from visual, flavor and textural standpoints.

Fortunately, beverage developers are not alone in their endeavors. A host of suppliers are coming forward with new, improved ingredients to help food scientists meet their goals.

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Inside INSIDER

Q. What are the most important attributes you look for when selecting functional beverages for your household?

A. I've upped my exercise regime so I look for RTD beverages with at least 15 g of protein, added vitamins and minerals, and low net carbs. My go-to flavor is of course chocolate—it does a body good.

Judie Bizzozero
Senior Editor

A. I am a keto gal, and I am always looking for a high-protein, low-sugar beverage. The increase in plant-based protein options has given me a tremendous amount to choose from.

Susan Ginn
Sales Support Coordinator

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About the Underwriter

www.cargill.com

Functional Beverages Deep Dive Report
Exclusively Underwritten by Cargill

Drinking to your health
Modern consumers have become increasingly attuned to the role a healthy diet can play in supporting health. Heightened expectations for ingredient transparency and widening awareness of good nutrition have expanded the market for functionally enriched foods and beverages beyond athletes to the average consumer. And thanks to the portable, go-anywhere convenience of beverages, they are fast becoming a popular source of targeted nourishment.

See how Cargill's depth of resources can help you succeed in the functional beverage space.

Health-supporting ingredients
From supporting heart health, to digestive function to increased dietary protein, Cargill offers an extensive portfolio of health-supporting ingredients. They include plant sterols, chicory root fiber and plant proteins, just to name a few.

Sugar reduction
Three in four consumers now say they are taking measures to limit or avoid sugars in their diets.* Whether prompted by health considerations or increased visibility of "added sugars" on labels, the shift is having a major impact on product formulation. Cargill offers a broad portfolio of sugar-reducing ingredients, including stevia, erythritol and reduced-sugar syrups.

Satisfying taste & texture
While consumers are definitely seeking out "better-for-you" foods and beverages, great taste and sensory enjoyment are the keys to repeat purchase. Cargill's toolkit includes not only a broad portfolio of functional ingredients, sweeteners and texturizers, but also the technical insight to ensure that the entire system performs effectively and efficiently.

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