MASTERING TASTE AT THE MOLECULAR LEVEL

FOR DELICIOUS, BETTER-FOR-YOU PRODUCT DEVELOPMENT

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"IT'S COMPLICATED."

Those two words could arguably qualify as the motto of the modern era. And if you conduct a quick poll with food-and-beverage professionals, you will find that they already prevail as the motto of better-for-you product development.

That's because better-for-you formulations circa 2024 have come to resemble intricate Jenga towers of ingredients chosen not just for their desirable attributes—think better-for-you nutrition, convenience, and, above all, taste—but for their ability to offset or even eliminate undesirable attributes like excess calories, "artificial" additives and "off" flavors that today's equally complicated health-conscious consumers avoid.

The sugar-reduction space is where the product development stakes are highest, where you find the most ingredient "solutions" claiming to crack this complex code. So why has none of these solutions turned out to be the "silver bullet" product developers hoped it might be?

Because no such silver bullet exists. The smart strategy for successful better-for-you product development involves replicating the taste characteristics of sugar at the molecular level—using an emerging class of taste modulating flavors that, as Casey McCormick, Vice President of Global Innovation, Sweegen, explains, "target specific receptors with a simpler sensory signal to create a more elegant sugar-reduction solution than the current approach of throwing the kitchen sink at the problem."

Sound like science fiction? It's a food-science fact for the Taste Blazers at Sweegen, and for the food and beverage brands slashing sugar and perfecting taste with their help.

Finding a delicate balance

Allany Chayasing is a Sweegen Taste Blazer—what Sweegen calls its top-tier product developers—as such, she understands how complex and multifaceted the current R&D landscape can be.

"Consumer desires are constantly evolving, so we have to be on top of key trends to create new products that resonate," she observes. "But we're also constantly trying to balance taste, availability of supply, innovation, safety, health and price—whether we're innovating a food or beverage or renovating one."

And when that food or beverage falls into the "better-for-you" column, Sweegen's specialty, the balancing act gets even trickier, as a single tweak to just one ingredient can require revision of the entire formulation.

Riding the sugar-slashing wave

There are more better-for-you options than ever, thanks to consumers' growing interest in adopting holistic wellness lifestyles.

And they're favoring low- and no-sugar options over traditional full-sugar ones. Grand View Research predicts the global market for reduced-sugar foods and beverages to grow at a compound annual rate of 8.9% from 2022 to 2030.

In response, brands have unleashed a wave of reduced-sugar products onto shelves that consumers might think got there by magic. Yet behind each product there isn't magic, rather a massive—and ongoing—reformulation effort that's much harder than it looks. And it's that hard because sugar adds much more to a formulation than "sweetness."

Going behind the scenes with sugar

"Sugar plays multiple roles in a food system," Chayasing explains. Its characteristic sweetness may take center stage, she notes, but it also acts behind the scenes to lend bulk, promote browning, balance acidity, cover bitterness and accentuate flavor.

What's more, sugar alters the physicochemical properties of a food system—its freezing point, its mouthfeel and texture, its ability to retain water, how long it lasts on the shelf, and more.

"So, let's say we're trying to reduce sugar in a jam-like fruit spread," Chayasing offers. "Sugar adds its sweetness to overcome the tartness of the fruit, but when we take out sugar, we also take away the major element that triggers the gelling structures from pectin. We've altered the water activity, too, potentially inviting microbial instability if we don't add preservatives or alter our processing methods."

And that's just the start. The lesson for product developers, she concludes, is that they "have to recognize which functional attributes they need to add back so they can recreate the delightful taste profiles people like, while also maintaining product performance."

An imperfect sugar-reduction toolkit

Fortunately, the alternative sweeteners now available to product developers do a much better job of replacing those functions than their forebears. Unfortunately, each still "has its pros and cons," says Chayasing.

Take polyols—sugar alcohols that long served as bulk sweeteners. While they help replace the volume that formulations lose when sugar levels fall, they don't have sugar's sweetness levels, they can cause gastrointestinal discomfort in sensitive individuals, and some can even produce a cooling effect that may be welcome in chewing gum but isn't in a barbecue sauce.

Allulose—or d-psicose, a lower-calorie fructose isomer—has entered the picture more recently. And like polyols, it helps replace sugar's bulk, also like polyols, it doesn't match sugar's sweetness levels. What's more, it's subject to excess browning and can bind so much water that it makes some formulations unworkable.

High-intensity sweeteners (HISs) fill the sweetness gap that polyols and allulose open, but their drawbacks leave their own gaps. For example, "Aspartame is unstable in acidic products and under high-temperature processing," Chayasing points out, "and it can also impart slight bitterness to a product's taste profile."

Acesulfame potassium, meanwhile, carries a bitter, even metallic note at high use levels. And though sucralose's sweetness profile approaches that of sucrose better than most HISs, "its sweetness intensity is extremely high and can linger extensively," Chayasing says.

Only natural ingredients, please

One of the biggest drawbacks with these HISs is their predominantly synthetic origins, which, in a consumer climate that exalts all things natural, anything "artificial" can be a deal breaker.

Fortunately, "As we've moved from the synthetic alternatives that dominated from the 1970s through the last 15-plus years, we've developed more natural solutions with broader consumer appeal."

CASEY MCCORMICK Vice President of Global Innovation, Sweegen

Stevia stands as a representative case. Extracted from Stevia Rebaudiana, a plant native to Paraguay and Brazil, it was initially heralded as the nature-based HIS everyone was searching for, with a sweetness intensity anywhere from 50 to 300 times sugar's.

But even stevia comes with a catch.

Its intense sweetness stems from compounds found naturally in the stevia leaf called steviol glycosides, with Rebaudiosides being chief among them. Scientists have identified an array of these Rebaudiosides, each with its own sweetness profile and intensity. Rebaudioside A, or Reb A, is the most abundant and traditionally the easiest to access.

But from a sensory standpoint, Reb A leaves much to be desired. "It can be super peaky in sweetness, but also has a sweet linger," Chayasing notes. "And at high concentrations, it can be bitter with licorice notes."

Because these flaws are hard for consumers to ignore, "many consumers have been burned by reduced sugar products with a ton of Reb A," Chayasing admits. "And though we're finding new Rebaudiosides and efficient ways of commercializing them all the time"—more on that later—"some formulators and marketers are hesitant to use stevia because of Reb A's bad rap."

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NATURAL > ARTIFICIAL

SWEEGEN'S PRODUCT OFFERINGS FEATURE NATURE-BASED SWEETENER SYSTEMS AND NATURAL FLAVORS FOR EXCEPTIONAL TASTE MODULATION

The sweet protein promise

One alternative they might explore is the growing class of protein-based HISs like Thaumatin, Monellin, Miraculin and Brazzein that offer yet another promising natural alternative to synthetics, particularly when sweetness intensity is a priority.

Consider, for instance, that Brazzein doesn't just display aspartame's 200-times sweetness relative to sugar, weight-weight, nor Reb M's 400-times sweetness, nor even sucralose's 600-times intensity. Brazzein is 2,000 times sweeter, weight-weight, than sugar.

This would be fantastic if it didn't have such a steep commercialization curve, as Brazzein and many other sweet proteins occur in minute quantities in obscure plants that grow in regions and conditions inhospitable to large-scale agriculture.

And in what's become a theme among sugar alternatives, sweet proteins also suffer from characteristic flavor flaws.

No wonder, then, that Chayasing accepts that "there is no single ingredient that can replace sugar one-to-one in all applications. I wish one existed, but that would be too easy, and my job would become very boring."

Conflicting taste signals

In the absence of that single ingredient that solves all taste challenges, McCormick points out, sugar-reduction efforts have historically "leaned very heavily on modulation."

By that, he means that formulators would start by cutting sugar, then replacing it with an imperfect alternative, covering that alternative's off notes with a flavor masker, then adding another suite of flavors to correct the imbalances the masker introduced, then use yet more flavors to bring up the desirable notes that the previous suite swamped—and soon enough they'd have such a pileup of sensory input that the sugar-like experience they were seeking was nowhere to be found.

"You end up with a lot of conflicting signals going to the brain, and you're also passing on a lot of ingredient costs to the customer, who then passes them to consumers. So, I think it creates as many problems as it solves."

CASEY MCCORMICK Vice President of Global Innovation, Sweegen

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Cracking the taste code

The wiser course is “to ‘turn off’ the notes we don’t want, allowing the signal we do want to come through very clearly,” he argues. That can be accomplished by ditching the blunt instruments of the past for precision tools that optimize taste in a targeted fashion.

Those precision tools are taste modulation flavors, or flavors with modifying properties (FMPs), “and everything we do at Sweegen is tied to our portfolio of proprietary molecules,” McCormick explains. “All of our taste optimization technologies are fueled by our proprietary molecules, which sets Sweegen apart from other companies. Our novel technologies exceed consumer expectations regarding the taste experience of better-for-you products because we focus on filling the consumer acceptance gaps in the space,” he adds.

Sweegen’s proprietary flavors for taste modulation live within its Tastecode™ natural flavor technology platform. Sweegen’s Taste Blazers draw upon these tools to optimize individual elements of the sensory experience at the molecular level—impacting the consumer taste experience by amplifying a product’s perceived taste, texture and flavor while also saving brands considerable time, cost and headache.

“We’ll deploy relatively simple flavors with one or two actives tied to our core portfolio to modulate a sensory pathway in a way that legacy technologies simply can’t. And that creates a profile that’s not overly modulated—because we’ve got two actives and not 25.”

CASEY MCCORMICK Vice President of Global Innovation, Sweegen

TRANSFORMATIONAL TASTE TECHNOLOGY

TASTECODE™ INSPIRED THE SWEETENSIFY™ COLLECTION, SWEEGEN'S EXCLUSIVE COLLECTION OF TASTE MODULATION FLAVORS POWERED BY SWEET PROTEIN TECHNOLOGY.

Remember those sweet proteins mentioned earlier that, while up-and-coming natural alternatives to synthetic HISs, still needed work? Sweegen has dived headlong into that work, scaling Brazzein's commercial production through precision fermentation and taking advantage of the fact the protein isn't just "insanely sweet," as Chayasing puts it, but is also "great as a taste modulation flavor when used at low levels."

So great, in fact that McCormick believes sweet protein Brazzein will "transform the industry."

Sweegen even has the ability to produce the protein at such high purity that Brazzein's flavor is now a feature, rather than a bug.

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The sweet equation is simple

Brazzein has a number of attributes that distinguish it from both contemporary natural sweeteners and even from other sweet peptides—the most significant attributes are associated with the biochemistry of taste.

When sucrose hits the palate, it binds to two sweet receptors on the tongue, T1R2 and T1R3. Most sucrose substitutes show primary affinity only for T1R2, Brazzein stands apart in its high affinity for T1R3, one of the two receptors that sucrose binds to.

"So it's a simple equation. It's a lot easier to tell your brain you're recreating the sugar experience if you're engaging the same receptor that sugar engages rather than modulating your way through only half of them. And Brazzein is the missing link."

CASEY MCCORMICK Vice President of Global Innovation, Sweegen

Thus, when Sweegen's Taste Blazers leverage Sweetensify™ Flavor Technologies to build reduced-sugar systems, they leverage Brazzein's T1R3 binding while also including sweetness that favors T1R2—like the signature stevia in from their Bestevia® collection—to generate a multifaceted, more sucrose-like sweet taste experience.

But the simple equation gets even better: We now know that the signal for umami—the "fifth taste" that unites sweet, savory, sour and more—also runs partially through T1R3. So not only does sweet protein Brazzein amplify sweetness via its T1R3 interaction; it can trigger umami, too.

"Again," McCormick states, "when we want to elevate all aspects of taste and flavor, being able to involve that umami pathway improves the odds even better. We've even found that Brazzein has the ability to boost certain tonal flavors that we directly attribute to that sensory pathway on the tongue."

A tale of two chocolates

So how do Sweegen's Taste Blazers turn all this insight into action? Chayasing recalls one sugar-reduction project that illustrates what happens when technology combines with trial and error to impact positive change.

The goal: step up the sweetness in a pair of no-added-sugar chocolate bars, one dark and one milk.

The customer's existing alternative sweeteners had too many off notes and weren't as sweet as the full-sugar targets, which were about 30% to 50% sugar."

ALLANY CHAYASING, Product Innovation Manager, Sweegen

What's more, though the zero-sugar bars had bulking systems that theoretically could've heightened the sweetening effect—one being a combination of polyols and fibers and the other polyols, fibers and allulose—"even with those ingredients in the formulations, the bars' sweetness was still below the full-sugar targets," she says.

Compatibility curveballs

The bars' chocolate bases posed their own challenges, as both, per Chayasing, were "super bitter." And without any moderation from milk powder, the dark chocolate's bitterness proved so "overwhelming" that the sweetness of the new system "would need to be high enough not just to cover that bitterness but to push through the base's fatty matrix and still be akin to the full-sugar control," she says.

As if that weren't enough, "Every ingredient needed to be compatible with chocolate," Chayasing continues. That meant some flavors had to be oil-soluble, while others would only work when powdered. Each system component would also have to mix completely into the chocolate.

The allulose-containing bulking system threw yet another curveball into the mix, as its high hygroscopicity gave the resulting base a softer texture than chocolate made with sucrose. "So, if this base were to make it to commercial scale," Chayasing notes, "there might be differences in tempering profiles, storage conditions, and shelf life."

Scaling the wall

Boldly, the Taste Blazers set to work.

"Since I needed a natural sweetener that was higher in intensity to pair with the bulking agents," Chayasing recounts, "I entertained the idea of monk fruit and stevia." But the former added "way too many undesirable tonal changes," she says, and its sweetness intensity couldn't overcome the fatty, bitter chocolate matrices.

Yet the formulations she tested containing only stevia failed to reach the full-sugar target's sweetness. "It was like I hit a wall," she says.

How did she get over the wall?

"We innovated a Sweegen Taste System that consisted of multiple Rebaudiosides from our signature Bestevia® portfolio, plus Tastecode™ Natural Flavors."

Calling upon stevia's best

They could accomplish this because Sweegen's Bestevia® portfolio—unlike the stevia leaf itself—isn't dominated by Reb A. On the contrary, knowing that a host of better-tasting Rebaudiosides exists—Sweegen integrated technology to get premium materials.

That meant leaning into bioconversion. As McCormick explains, "We start with the product from the field, which by its nature has very little of the Rebaudiosides that aren't A. Then we treat that agricultural leaf with specific enzymes naturally present in the plant to optimize and target the Rebaudiosides we want."

The process generates its intended glycosides "at very high purity and low cost," he goes on, "and the broad range of molecules we get lets us more elegantly replicate sugar's temporal profile." Meanwhile, the regulatory approval the compounds have received both domestically and abroad lets customers access more markets.

An expanded sweetness toolkit

With her toolkit of Rebaudiosides expanded, Chayasing tried one of the "sweetest and most sugar-like in the plant," she says. But frustratingly, its sweetness wasn't quite sugar-like enough, particularly in its onset, and so the sweet profile it produced "was dampened in upfront sweetness by the chocolate matrix."

That meant Chayasing would need a Rebaudioside with a stronger sweetness onset. And though the one she found "has limits due to solubility issues and off notes when used at high concentrations," she notes, at low percentages its upfront sweetness "shifts the sweet profile forward."

"I also used very low percentages of other Rebaudiosides to smooth out the taste experience. While they may not have high sweetening power on their own, they help amplify the sweetness to be 'fuller' and less 'one-note.' By leveraging the attributes of different Rebaudiosides this way, I can create a sweet profile that's closer to sugar in a specific matrix, even if that matrix is complicated."

ALLANY CHAYASING, Product Innovation Manager, Sweegen

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Synergistic technology approach

But even with the sweetness profile locked in, the system's sweetness intensity still didn't rise to the full-sugar occasion. And adding more stevia just wouldn't cut it. "At a certain point," Chayasing cautions, "more stevia doesn't contribute more sweetness. You hit a sweet plateau." Go even higher and "you're introducing the potential for off notes from the high use of Rebaudiosides—and you're increasing cost-in-use with no benefit."

That's where Sweegen's Sweetensify™ Flavors, powered by sweet proteins, "synergize with our Bestevia® products," she explains. Again, thanks to Brazzein's action at the molecular level, using Sweetensify™ Flavors "helped push up the max sweetness to overcome the chocolate matrix and be more on-par with the full-sugar target," she says.

Chayasing also squeezed more utility out of the system's Bestevia® by using Sweetensify™ Flavors, powered by sweet proteins, to attenuate other chocolate off notes. "First I tried to identify all the negative attributes in the bases that differed from the full-sugar target: astringency, bitterness, acidity, graininess," she says. But because some of these notes are actually attributes in chocolate, "I needed to benchmark my samples against the target rather than what's desirable in general."

Her Tastecode™ testing led her to a variety of natural flavors that helped adjust astringency and acidity, which she hoped would "reduce the 'noise' blocking the sweetness and allow it to shine through." But it wasn't until she landed on Tastecode™ Bitter Smoothing Natural Flavor Tech that she found the "most bang to really help clean up the off notes," she concludes.

Hitting the sweet spot

Following some tweaks to bring formulation costs closer to the sweet spot, Chayasing was “proud to say that the sweetness was a match in the milk chocolate product. And while I got it close to the full-sugar target in the dark chocolate, it was still an improvement from the previous sweeteners. And if I can make something taste much better than it did in the first place, then I call that a win.”

The whole endeavor shows how agile problem-solving and curiosity in the sugar-reduction space yields results for everyone—brands and consumers.

Reflecting on a job well done, Chayasing puts it this way: “Better-for-you product development focusing on sugar reduction is like a puzzle that you can eat. It’s satisfying when you can fit all the pieces together to create a food or beverage product that tastes delicious. And because we’re constantly pioneering new products and techniques that enable this kind of innovation, we’re confident that we can keep helping brands build products that exceed expectations.”

BRAZZEIN GETS BETTER

With a sweetness intensity 500 to 2,000 times that of sucrose, the sweet protein Brazzein is building a reputation—and rightly so—as a powerful sugar-reduction tool. But Brazzein's benefits extend well beyond sweetness...

- It exhibits unrivaled pH and thermal stability, maintaining its structure and function through pasteurization, baking and the toughest heat treatments used in food production today.
- Its high solubility is the perfect fit for beverage applications that need a boost in natural, sugar-free sweetness.
- As a taste modulation flavor, Brazzein blocks bitterness, reduces astringency and sweet linger, eliminates "funky" aftertastes and even enhances mouthfeel.
- Precision fermentation lets Sweegen manufacture this rare protein at high purity and scale; coupled with the ingredient's intense sweetness, this keeps cost-in-use competitive.
- Sweegen's Brazzein was the first to achieve commercial availability and receive regulatory approval from the Flavor and Extract Manufacturers Association.

The team at Sweegen is forging the future of wellness in food and drink by pioneering these exciting new ingredient technologies and innovations. Learn more today at sweegen.com.

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Sweegen provides taste optimization technologies for food and beverage manufacturers around the world.

We are on a mission to reduce sugar, artificial sweeteners, and other unwholesome ingredients in the global diet. Partnering with customers, we create delicious, better-for-you products that consumers love. With the best modern sweeteners in our portfolio, such as Bestevia® Rebs B, D, E, I, M, and N, and sweet proteins Brazzein and Thaumatin, along with our deep knowledge of taste modulators and texturants, Sweegen delivers market-leading solutions that customers want, and consumers prefer. We're not simply flowing with the future; we are creating it.

Well. Into the Future.

For more information, please contact marketing@sweegen.com and visit Sweegen's website, www.sweegen.com.

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