



Exploring the science of sweet

For many shoppers, sugar remains a point of contention. Their indulgent side is drawn to its sweet profile, while they remain conscious of sugar consumption. But what if consumers didn't have to choose?

That's the ambitious goal Cargill's Smaro Kokkinidou aims for every day. A Principal Scientist Lead in the company's vast sweetener R&D program, Kokkinidou envisions a day when consumers can enjoy all manner of sweet delights made with little or no added sugars. Reaching that goal, however, starts by recognizing sugar's multifaceted role in food and beverage products – and understanding the nuances of taste and flavor.

The sugar challenge

Sugar is the gold standard of sweet taste, one of the five basic tastes perceived by the tongue. But sugar also impacts flavor – which is a more complex sensory impression, spanning taste, aroma and mouthfeel.

"With sugar, it's not just about sweet," explains Kokkinidou. "Sugar can enhance or suppress flavor attributes, further affecting flavor perception and influencing liking. For example, sweetness from sugar can enhance how we perceive fruit and chocolate flavors, resulting in a more enjoyable eating experience."

Sugar can also promote color and flavor formation through non-enzymatic browning mechanisms like the Maillard reaction, resulting in favorable color, aroma and taste changes. Additionally, research suggests there's a link between sugar and aroma intensity – another factor in the flavor equation. The human brain learns to associate specific aromas and tastes, something scientists call flavor congruency. Over time, odors and tastes normally found together, such as vanilla and sugar, are perceived as a single sensation. As a result, when we smell vanilla, the brain expects to perceive sweetness.

At the same time, sugar helps suppress negative flavor attributes like bitterness, sourness and saltiness. "There's a reason products like energy drinks are often packed with sugar," Kokkinidou says. "Formulators use sugar's flavor-modifying properties to mitigate the bitterness associated with caffeine and other compounds typically found in these beverages."

Sweet solutions

Given sugar's complicated role in taste and flavor, successful sugar reduction requires a deep understanding of both attributes, enabling formulators to remove added sugars from foods and beverages, yet still deliver the sweet sensations consumers desire.

When faced with a sugar-reduction challenge, Cargill's Kokkinidou often starts to build back sweetness with a stevia-based solution, guided by a brand's product development objectives such as sweetness targets, sugar-reduction goals and label expectations. For relatively modest sugar reductions, she might suggest Truvia® stevia leaf extract; for deeper reductions, there's the leaf-based ViaTech® stevia leaf extract line, which includes SKUs for specific applications, or the company's premier EverSweet® stevia sweetener, which is produced via fermentation.

"With EverSweet, we pioneered a whole new approach to stevia production, using advanced fermentation technology to produce the ingredient more affordably and with less land and water than traditional agronomic practices," Kokkinidou explains. "The resulting sweetener brings to life the sweetest components of the stevia leaf – Reb M and Reb D – to delight taste buds and enable up to 100% sugar replacement."

As she fine-tunes the sweetening system, Kokkinidou may add Zerose® erythritol to the formula, which helps round out the sweetness profile of many high-intensity sweeteners, stevia included. However, sometimes, sweeteners alone aren't enough. Formulas that include other ingredients with negative flavor attributes may require the help of modifiers and maskers to enhance consumers' flavor perceptions.

Cargill's Kokkinidou likens flavor perception to pixels on a screen, which come together to create a recognizable image. "When we consume foods and beverages, all the aroma, taste and texture signals jump to different brain processing centers," she explains. "As our brain analyzes these signals, we form flavor expectations based on past experiences."



By leveraging those linkages, formulators can use non-characterizing flavors and other ingredients to improve the overall flavor experience. “We’ll use flavor modifiers to deliver aroma or taste compounds at (or very close to) the point where they are detectable by the brain, but not yet recognizable,” she explains. “In this way, we can introduce a sensory signal that ‘masks’ an offending attribute, enhances a positive one, or sometimes does both – without adding to the characterizing flavor noise.”

Other non-characterizing flavor modifiers impact how taste and aroma compounds either release and are perceived, or how they interact with taste receptors by altering the temporal profile (timing) of different sensory attributes or the overall intensity. For example, formulators sometimes use low, (non-characterizing) levels of vanilla or other sweet or fruity aromas. Deployed at the right levels, these compounds may help improve a product’s flavor profile by increasing perceptions of sweetness, reducing perceptions of bitterness and/or enhancing characterizing flavor profiles.

Cargill’s newest sweetener system, EverSweet® stevia sweetener + ClearFlo™ natural flavor, offers another approach, bringing sweetener and flavor modifier together. It results in a sweetness profile and experience that is even closer to sucrose than EverSweet alone – especially in more-concentrated applications. At the same time, it helps manage off-flavors from other ingredients used in formulation, including earthy and beany notes from plant-based proteins, bitterness from caffeine or vitamins, or metallic tastes from potassium chloride or other minerals.

In addition, the sweetener system enhances characterizing flavor profiles and has a great impact on mouthfeel perceptions, especially in no-sugar-added formulations.

“It represents a huge leap forward in sweetening technology and is a game-changer for stevia,” Kokkinidou says, noting that the label-friendly sweetener is especially well-suited for many beverage and dairy applications.

Teasing out texture

Cargill’s zero-calorie stevia solutions can go a long way toward closing the sugar sweetness gap, but they’ll typically need help addressing the final component of flavor: mouthfeel. While sugar’s influence on texture varies by specific application, in beverages alone, sugar binds to water and can increase viscosity, provide desired mouthfeel, increase boiling temperature, decrease freezing temperature, decrease water activity, and alter the behavior of proteins and starches.

“When it comes to texture and mouthfeel, sugar is a remarkable substance, contributing to a myriad of functions in a formula,” Kokkinidou says. “That’s why it often requires multiple added ingredients to do the same job in food and beverage formulations.”

To support developers throughout their sugar-reduction journey, Cargill’s portfolio extends to the texturizing space, with solutions that include starches, polyols, maltodextrins, corn syrup solids, hydrocolloids and more. That ingredient toolbox, combined with Cargill’s deep application expertise, gives customers a huge advantage, enabling them to address sugar reduction holistically, regardless of their formulation challenge.

“When it comes to food and beverage choices, consumers don’t want to compromise on taste and flavor – and neither do I,” Kokkinidou says. “Fortunately, we have the tools and expertise available to help brands deliver on great taste and sugar reduction, a combination with major appeal to today’s discerning shoppers.”

Learn more about Cargill’s industry-leading solutions for sugar reduction at cargill.com/sugarreduction.