

2018 SWEETENER SYSTEMS CONFERENCE

What's Inside on Sweeteners...

- Consumers Want Sugar Reduction, Not Sweetener Reduction
- Impact of “Added Sugar” Labeling on Ingredients
- Sugar vs. Obesity Debate: Don't Believe Everything You Read
- Progress in High-potency Sweetener Enhancers
- Optimum Sensory Performance & Cost of High-potency Sweeteners
- Food Analysis Industry Not Ready for Nutrition Labeling Law Changes
- Applications Panel: Sugar Reduction Tips



Note: This digital magazine, initially posted at <https://GlobalFoodForums.com>, is now at <https://foodtrendsnotech.com/global-food-forums-magazines/>



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Raising the bar on sugar replacement. Natural taste and texture, healthier recipe.

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2018 Sweetener Systems Conference Summary

Driven by health issues like increasing rates of diabetes and obesity, health organizations and regulatory agencies around the world are working to decrease the consumption of caloric sweeteners, even as consumers have their own opinions as to what is healthful.

With the goal of providing insights into these and related topics, Global Food Forums held its 3rd annual Sweetener Systems Conference on October 23, 2018, in Oak Brook, Ill., USA. The conference opened with an overview of global consumer attitudes toward sweeteners, followed with an update on “Added Sugar” labeling and how individual ingredients should be handled. Attendees learned about analytical methods to ensure a company’s compliance with these new regulations, including how the labeling of certain dietary fibers could be impacted.



Presentations from the 2016 to 2018 Sweetener Systems Conferences can be accessed at www.GlobalFoodForums.com/store/Sweetener-Systems.

A review of evidence was given on the likelihood that reduced-sugar consumption through product formulation and changes in

public policy would impact the trend toward obesity.

Additional presentations focused on aspects of sugar reduction, including the use of third-generation stevia extracts and how sugar taste can be enabled through the use of taste modulators and enhancers. Three speakers gave concise presentations as part of an “Applications Panel: Technical Tips for Sugar Reduction.”

The next Sweetener Systems Conference will be held March 24, 2020, followed immediately by the 2020 Clean Label Conference on March 25-26, 2020.

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The Global Food Forums Story

Welcome! We hope you find this, our 3rd Sweetener Systems Post-Conference Magazine, useful.

We launched Global Food Forums in 2012 with the vision of developing a family of in-person, niche product development conferences for the food, beverage and nutritional products industries.

Each of our events, which also includes the Clean Label Conferences and Protein Trends & Technologies Seminars, is tied to an important, long-term consumer and industry trend in which applied food science plays a crucial role. The technology-based programs are designed to provide R&D and other food scientists with practical and impartial formulation advice, along with consumer insights, information on emerging ingredients, regulatory updates and other factors impacting product formulations. Our Sweetener Systems Conferences fit well with this goal.



Sugar's benefits in foods go far beyond sweetening, as its physio-chemical properties improve the color, flavor, texture and even microbial safety of products. Consumer sweetener preferences will continue to evolve. Nutritional knowledge, ingredients and sweetener technologies will continue advancing. Sweeteners will be a turbulent topic with challenges and opportunities for years to come.

With food technologists as core customers, our company decisions are guided by how they will impact this community's event experience. To date, our events have drawn over 3,500 attendees. They range from bench-level food scientists to VP/directors of R&D, regulatory and other functions related to product development, as well as those interested in interacting with this community to better understand their needs and challenges.

Our next Sweetener Systems Conference will be held on March 24, 2020, as a pre-conference to the 2020 Clean Label Conference March 25-26. We hope you'll attend these. We'll work hard to make it one of your best conference experiences ever! For more information, visit: <https://www.globalfoodforums.com/events/>.

Warm regards,
Peter Havens & Claudia O'Donnell
Co-owners, Global Food Forums®, Inc.

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For an inside look at the team, visit www.globalfoodforums.com/about-us/gff-team

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Uncertainty Leaves Consumers in a Sweetener Paradox

“SUGAR REDUCTION may be the top-cited dietary priority globally, but consumers aren’t quite willing to give up sweeteners completely,” said Julie Johnson, General Manager, HealthFocus International. She also noted that consumer perceptions of sweeteners are complicated. Johnson gleaned her information from a “HealthFocus’ 2018 Global Trends Study” that interviewed more than 12,000 consumers in 22 countries.

Johnson cited three overriding trends—product personalization, clean eating, and calorie and weight issues that help influence consumer sweetener perceptions. The first trend, where consumers wish to personalize food and beverage taste preferences, included the following statistics: Globally, 48% of consumers interviewed indicated they always or usually add something to their foods and beverages to adjust taste (only 26% in the U.S.). “Consumers want control of their taste preferences,” she said, citing yogurt cups that add honey or fruit preparations on the side.

The second trend is a general interest in “clean eating.” Globally, 63% of people (versus only 39% in the U.S.) claim to be interested in eating clean, noted Johnson. And thirdly, consumer concerns about calories and weight track well with their attitudes toward sugars and sweeteners. “In the U.S., food and beverage sugar and caloric contents top the informational items sought by consumers on food package labels,” said Johnson.

Top purchase-decision influencers identified in the 2018 study remain: price (56%), followed by better taste (52%) and recognizable ingredients (49%). Drilling down, 41% of respondents listed no artificial sweeteners, and 40% listed lower sugar as “extremely” or “very important” to them. When asked: “Which of the following 10 factors had become more important to them over the past year,” 54% put reducing sugar at the top of their list.

Asked to choose between 10 different factors that might make food and beverages appear healthier, sugar reduction ranked #2 at 52%, while using no artificial sweeteners rated #6 at 47%. So, to summarize thus far... consumers want less sugar, but does that mean that they want to sacrifice sweetness?

“Don’t overlook that this study was based on stated *attitudes* and *perceptions*, not necessarily *actions*,” warned Johnson.

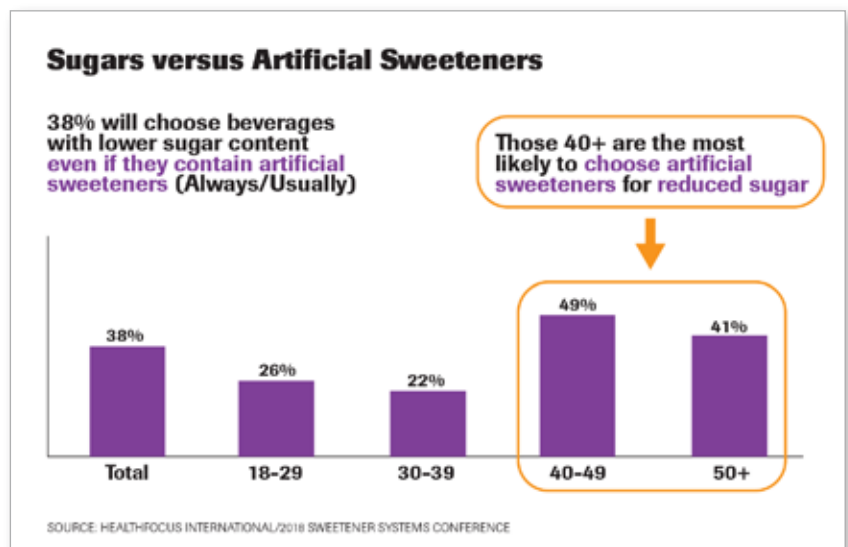
Actions do speak louder than words. A closer look at specific sweeteners suggests that familiarity with particular sweeteners improves perceptions thereof.

In the U.S., reducing sugar and avoiding artificial sweeteners are high priorities. But, globally, 96% of consumers around the world still use sugar, and 78% admit to using artificial sweeteners (67%, in the U.S.). Age is also a factor, with older consumers more amenable to using artificial sweeteners to cut calories. In the U.S., while only 18% of shoppers believe artificial sweeteners are safe, 26% believe that they are a good way to reduce sugar content, and 38% will choose beverages with lower sugar content, even if they contain artificial sweeteners. In other words, they make tradeoffs.

U.S. consumers are also far more likely than their global counterparts to rate sweeteners negatively: In the U.S., less-than 10% of respondents rated 15 specific sweeteners as “good,” and only honey and maple syrup were rated positively by more than 50%. Globally, consumer antipathy toward artificial sweeteners as a category turned neutral regarding specific high-potency sweeteners, whether they were of natural origin or not.

Johnson also posted data suggesting a continued erosion of consumer opinion toward artificial sweeteners over time. This included stevia. Unfortunately, consumers in this study appeared to conflate “artificial” sweeteners with natural high-potency sweeteners (such as monk fruit or stevia leaf extract), suggesting that consumers may require more education on these specific sweeteners.

In summary, sugar reduction is a top global priority among consumers and the top dietary priority in the U.S. However, consumers aren’t willing to give up sweeteners altogether, which opens up major opportunities for non-sugar sweeteners. And, whereas views of virtually all sweeteners and especially “artificial sweeteners” remain generally negative, the confusion and



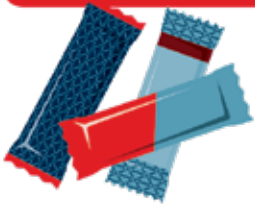
Older people, especially, are willing to trade off their concerns about artificial sweeteners for the benefits of caloric reduction, a likely reflection of their health priorities.

CLEAN-LABEL SUGAR REDUCTION MADE EASY

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negativity surrounding these ingredients lessens considerably when high-potency sweeteners are addressed individually. This should serve as a call to food and beverage ingredient marketing departments everywhere.

“Understanding Shopper Attitudes towards Sweeteners in the U.S. and Beyond,” Julie Johnson, General Manager, HealthFocus International

Confusion Abounds with FDA’s Proposed Added Sugar Labeling

ANTICIPATE TURBULENCE AHEAD! Mandated FDA changes to the Nutrition Facts label in order to accommodate “added sugar” labeling requirements are intended to help, but can also potentially confuse suppliers, manufacturers and consumers, noted Lauren Swann, MS, RDN, LDN, President and CEO of Concept Nutrition, Inc., in her presentation “An FDA Update: Sugar Ingredients’ Impact on Added Sugar.” She added: “This poses a huge educational challenge for government, industry, academic and public health authorities.”

Swann explained that, “this most recent revamp of FDA regulations is designed to support public health goals in line with the 2015 Dietary Guidelines Advisory Committee (DGAC) recommendations, which (stipulated) that consumers limit their daily caloric intake from added sugars to 10% of total intake in order to reduce their risks of chronic heart disease.” Swann wondered why the DGAC focus was on sugar links to heart disease, rather than the more immediate public health risk posed by type II diabetes.

Formerly, Dietary Fiber and Sugars were listed under the designation of *Total Carbohydrates* in the nutrition label, which includes complex-but-easily-digestible carbohydrates, such as starches and maltodextrins. Under the new label requirements, *Sugar* is redesignated as *Total Sugars*, to which is added the sub-designation, Includes “x”g *Added Sugars*.

One problem, according to Swann, is that the numbers for dietary fiber and sugars may not calculate to total caloric value. “Consumers tend to equate carbs and sugars with calories.” The new *Total Sugars* and *Added Sugars* designations, which include both digestible and non-digestible mono- and disaccharides, must be listed irrespective of caloric content or digestibility—e.g., 0-cal/g erythritol versus sucrose. So, some sugars don’t get counted. Confused yet?

The new *Added Sugars* designation is defined as sugars “added during the processing of foods or packaged as such.” These in-



■ **Fruit pieces, dried fruit, pulps or purees do not need to be labeled as Added Sugar when added to maintain the fruit properties of products not generally considered to contain Added Sugar.**

clude: honey and syrups; free sugars (mono- and disaccharides); and sugars from concentrated fruits and vegetable juices. As a result, “I have clients scrambling to get these ingredients out of their products,” said Swann.

Another complication is that, whereas there is no %Daily Value (%DV) for *Total Sugars* (which would be required to establish a defined regulation for a “low in sugar” claim), there is now one for *Added Sugars*, “which I find rather odd,” commented Swann. The new %DV is 50g per 2,000 calories.

Not labeled as *Added Sugars* are: fruit and vegetable juice concentrated from 100% juice to be reconstituted to single strength by consumers or processors; used toward meeting a required %-juice designation; used for °Brix standardization; or used in standardized preserves, jams, jellies and for the fruit component of spreads. “Neither are fruit pieces, dried fruit, pulps or purees which maintain the fruit properties of products not generally considered to contain *Added Sugar*,” said Swann.

Reference °Brix values for common single-strength (unconcentrated) fruit and vegetable juices [21 CFR 101.30(h)], together with calculation models for determining added sugar values, can be found at the FDA’s website, said Swann. However, there may be ingredients and formulation scenarios beyond those addressed in these guidance documents. Accounting for changing sugar contents due to fermentation and enzymatic browning poses yet another challenge.

Unfortunately, there exists no laboratory methods that distinguish between sugars inherent in the product and added sugars, so manufacturers are obligated to maintain very detailed records at all regulatory compliance levels of the supply chain in order to demonstrate compliance.

In response to a question from the audience, Swann indicated that monk fruit (or *luo han guo*) juice, which contains sugar, but is 15-20X sweeter than sucrose, could be added to a product at single-strength without affecting its *Added Sugar*

designation. “That would not be the case if it is added as a concentrate, (though).”

Swann commented that FDA Commissioner Gottlieb has indicated that the FDA is still looking for a final guidance, but that it would like to have everything finalized by early 2020. She strongly recommended that processors closely follow developments and continue submitting comments at <https://www.regulations.gov>.

“An FDA Update: Sugary Ingredients’ Impact on Added Sugar Labeling,” Lauren Swann, MS, RDN, LDN; President and CEO, Concept Nutrition, Inc.”

High-Value Evidentiary Studies Refute the Correlation Between Added Sugar and Obesity

AT THE OUTSET OF HIS TALK, “Reducing Added Sugars: Will It Reverse the Trend Toward Overweight & Obesity,” John White, Ph.D., President and Founder, White Technical Research, asked how many in the audience believed that sugar consumption was correlated with obesity. About 40% said they were in agreement.

Added sugars as the root of many of contemporary American’s health problems was referred to by White as the “added sugars hypothesis” which has two key justifications: 1) Significant diseases are increasing as sugars increase in the U.S. diet and 2) high value, cause-and-effect evidence uniquely links added sugars metabolism to these diseases in humans at typical exposure levels and patterns. Neither of these hypotheses are true, asserted White. “There has been a great deal of pressure on industry to reduce added sugars,” he noted, “but is there evidence-based research to support such decisions?”

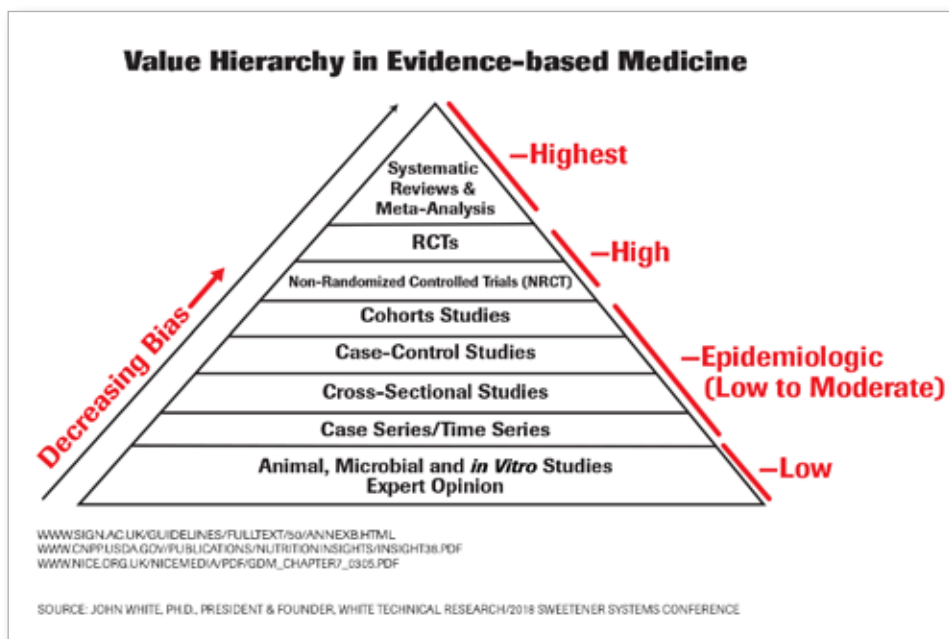
Scientific evidence is not all created equal. The evidence pyramid (see chart “Value Hierarchy in Evidence-based Medicine”) indicates that systematic reviews and meta-analyses of randomized controlled trials (RCTs), followed by randomized/non-randomized controlled trials have the least likelihood of bias. Epidemiological and animal data is often used to associate HFCS and fructose consumption with disease, although the FDA considers both to be of low evidentiary value for establishing cause and effect, noted White.

Negativity regarding fructose grew with the claim that an increase in consumption of HFCS is related to the epidemic of obesity, a temporal association that did not in any way establish cause and effect. In fact, per capita availability trends from the USDA for sucrose and HFCS show that sucrose consumption increased 40% between 1910-1921 and remained constant for >50 years. HFCS was introduced in the market in the late 1960s and rapidly gained market share at the expense of sucrose.

“What isn’t acknowledged is that HFCS use peaked in 1999,” said White, “and has been in steep decline for nearly two decades. This decline has occurred as obesity rates continued to rise,” and the data have shown no positive association between HFCS and obesity for 19 years.

White explained that U.S. per capita energy intake increased by 449 kcal/d (21%), between 1970-2010. Notably, increased energy from caloric sweeteners was minor, accounting for <8% of this energy increase. Energy from cereal grains and added fats increased disproportionately, accounting for >90% of the increase. “The most likely contributor to overweight and obesity is an imbalance between energy intake and expenditure, not increases in sugar intake,” said White.

Fructose studies don’t model the range of human intake, White explained. Using NHANES data, fructose intakes are on average 9.1% energy (E) and 14.6% E for the highest 5% of fructose consumers. White presented an overview on 57 human and animal papers reporting adverse effects of fructose. However, he stressed



Animal trials, which are so often used as conclusive standards for determining test results, actually fall at the low end of the value hierarchy pyramid in evidence-based medicine. Epidemiologic data was heavily emphasized in the 2015 Dietary Guidelines for Americans, even though it is generally recognized to be of low-to-moderate evidentiary value.

that these studies fed extreme fructose doses, exceeding the 95th population percentile intakes in many human studies by 1.5-3-fold, and in animals by >4-5 times.

White also emphasized that humans don't eat fructose or glucose alone, but always in combination in the diet from fruits, vegetables and nuts, as well as added sugars. "Extreme dosing under conditions of exaggerated protocols bias biochemical outcomes," he concluded.

In short-term studies of human subjects consuming HFCS and sucrose in randomized, controlled trials, few differences were found for clinical markers of obesity (plasma glucose and insulin; ghrelin and leptin; triglycerides and uric acid; hunger and satiety) over the range of exposure from 9%-15% E as fructose (45-75 g/d) (*Rippe et al. 2013. Adv Nutr./ https://bit.ly/2SaoWoo*).

In longer term studies of 10 weeks and more, no significant differences between three levels of HFCS and sucrose intake (8, 18 or 30% of isocaloric energy in 342 individuals) were reported for these markers.

Recent meta-analyses—the highest evidentiary value—have assessed the relationship of sugars to chronic disease. Isocaloric (equal calorie basis) comparisons of fructose with other carbohydrates (sucrose, HFCS, lactose, starch) found no adverse effects on body weight, fasting lipids, blood pressure, uric acid concentration, glycemic control and insulin sensitivity, postprandial lipids and markers of non-alcoholic fatty liver disease (*Khan et al. 2016. Eur J Nutr/ https://bit.ly/2SPZYdQ*). Some differences in these metabolic markers were observed with hypercaloric feeding trials, in which excess calories from fructose were added to a diet compared with the same diet without the excess calories. These variances were most likely due to confounding from extra calories, rather than fructose.

White concluded that high-level evidence from systematic reviews/meta-analyses and randomized/non-randomized controlled studies does not support a direct causal relationship between added sugars and obesity and overall disease. He stressed that considering the disproportionate increase in consumption of added fats and cereal grains over the past 50 years, it is unlikely that reducing added sugars will reverse the trend toward overweight and obesity.

"Reducing added sugars: Will it reverse the trend toward overweight & obesity?," John S. White, Ph.D., President and Founder, WHITE Technical Research

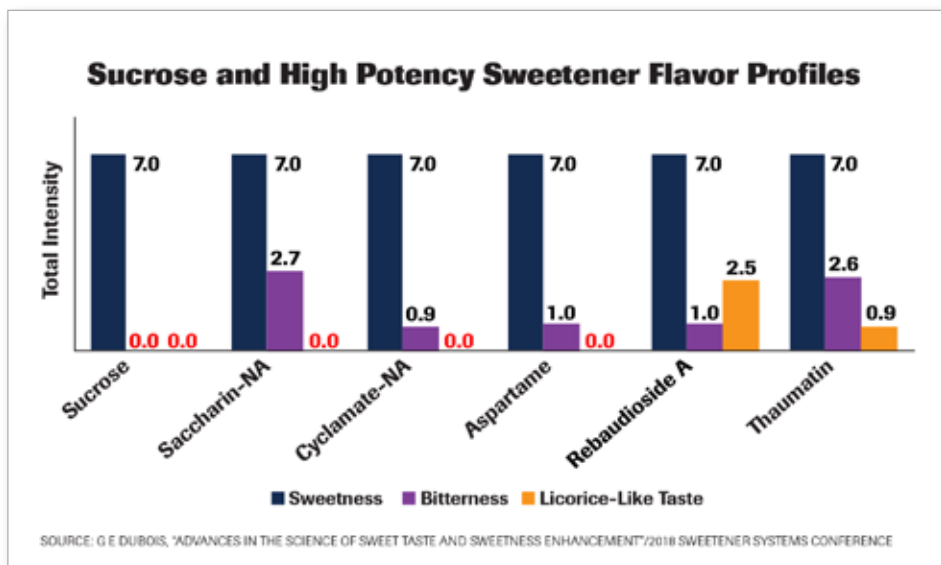
Progress on High-Potency Sweeteners, Taste Modulators and Enhancers Continues

GRANT DUBOIS, PH.D., Consultant, Sweetness Technologies, LLC, reviewed the progress made on natural high-potency (HP) sweetener systems for food and beverages by offering tantalizing insights on how to resolve some of their negative taste and flavor attributes, in his presentation titled "Replication of Sugar Taste Enabled by Taste Modulators and Enhancers."

Earlier work with HP sweeteners and sweetness enhancers recognized the importance of both maximal sweetness intensity and taste quality. However, DuBois listed six additional criteria for use in determining the commercial viability of such ingredients: safety, stability, solubility, cost, patentability and consumer acceptability.

A major research focus today is the search for all-natural HP sweeteners and sweetness enhancers. Interest in these ingredients began to grow at The Coca-Cola Company in the 1990s, recalled DuBois. This led to the development and commercialization of rebaudioside A (REBA)—a sweet-tasting diterpenoid glycoside isolated from South American stevia plant leaves. "One challenge with REBA was a maximal sweetness response at ambient temperature of <10% sucrose equivalency (SE). However, in cold solutions, that maxima increased to 18% SE, so it wasn't as bad as it first looked, explained DuBois.

Unfortunately, as with other natural HP sweeteners, off-tastes were an issue: Most commercial REBA products exhibit distinctive bitter and licorice-like notes. DuBois explained that the REBA



Issues associated with bitterness and off-flavor profiles illustrate the trade-off between flavor and purity in HP sweeteners.

The Cost of Sweetness

A key metric for commercial viability is cost. Beverage companies measure ingredient cost impacts in terms of cost/unit case. “If we use HFCS as a benchmark, the sweetener cost is about US\$0.51/unit case for a beverage like Coca-Cola. In contrast, the cost/unit case for a beverage like Diet Coke sweetened with aspartame today is ca. US\$0.03-0.04 (ca. US\$0.33 in 1985 when aspartame was under patent protection),” noted Grant DuBois. Currently, a blend of REBA with erythritol to balance the sugar taste profile and which tastes pretty good, incurs a cost of about US\$0.99/unit case. In his opinion, the cost threshold for viability should be ca. US\$0.40/unit case, so there is work to be done.

under study in early work was 97% (min) purity and that “batch-to-batch bitterness and licorice-like taste variability suggested the culpability of contaminants.” Today, REBA of higher purity is available with negligible off-tastes, albeit somewhat more expensive. (See sidebar “The Cost of Sweetness.”)

Additionally, the challenge of social perspectives exists. For example, new ingredients must weather reflexive and hostile social media storms. When aspartame was first introduced, activists charged that the breakdown of aspartame into phenylalanine (Phe) and methanol posed severe public health threats. However, perspective matters: “If I eat 100g of roasted chicken, I ingest 13x the Phe that I get from the aspartame in a 12oz Diet Coke, while 12oz of tomato juice provides 5.9x the amount of methanol generated from the aspartame in a single Diet Coke,” countered DuBois.

More than 40 sweet diterpenoid glycosides have been isolated from the stevia plant of which REBA was one of the first to be brought to the market. In recent years, rebaudiosides D (REBD) and M (REBM) have been commercialized, although they are present only at very low levels in the plant. Because of their low natural abundances, REBD and REBM are manufactured in bioconversion or fermentation processes and therefore cannot be labeled as “stevia leaf extracts,” as is the case for REBA. Another commercialized terpenoid-type sweetener is the triterpenoid monk fruit sweetener group, members of which are known as mogrosides. The monk fruit sweeteners are very challenging to purify and are available in a range of purities.

Other categories of natural HP sweeteners are on the market or in development and include proteins (e.g., thaumatin and brazzein) and amino acids (e.g., monatin). Each has its own problems, ranging from licorice flavors (thaumatin); linger-

ing sweetness profiles (thaumatin, brazzein and monatin); to rapid-degradation into foul-smelling derivatives (monatin). Neohesperidin dihydrochalcone, a flavonoid-type sweetener, is commercially available and claimed by some to be natural but does not occur in nature.

DuBois equivocated on the opportunities presented by flavors with modifying properties (FMPs) of the positive allosteric modulator (PAM) type. PAM FMPs significantly enhance the sweetness intensities of carbohydrate sweeteners. Dihydroxybenzoic acid, for example, will increase the sweetness perception of sucrose by 1.3-fold and fructose by 1.2-fold he noted.

“While PAMs were hoped to be a big deal for us when I was with The Coca-Cola Company, they ultimately were not,” said DuBois. The reason? *In vivo*, “the probability of sucrose and PAMs binding at a taste receptor at the same time, as required to enable this synergistic response, is far too low; and so, the hoped-for 10-20-fold enhancements were never found.”

While PAM FMPs have not realized significant commercial success, sweetener FMPs such as glucosylated steviol glycosides (GSGs) have realized success as natural flavors which enable reduction of caloric sweetener levels. These FMPs are used below their sweetness detection thresholds and thereby enhance sweetness by 1.1-1.2-fold.

One area in which very significant progress has been made is in the identification of taste modulators for HP sweeteners. “In early work, we noticed that osmolytes worked well at eliminating the lingering sweet aftertastes of HP sweeteners.” As example, adding salt at 500 mg/L to REBA “eliminated the lingering sweetness effect; however, such formulations were too salty.” Erythritol was also found to be very effective in elimination of the REBA sweetness lingering aftertaste, but cost remains the challenge with REBA/erythritol formulations.

In closing, DuBois hinted at major developments in taste modulation technology on the verge of disclosure. Stay tuned.

“Replication of Sugar Taste enabled by Taste Modulators and Enhancers,” Grant DuBois, Ph.D., Consultant, Sweetness Technologies, LLC

Food Technology, Neuroscience & 3rd Generation Stevia Extracts

IN HIS PRESENTATION “3rd Generation Stevia Extracts: Neuroscience, Ingredient Technologies and Food Applications,” Alex Woo, Ph.D., CEO & Founder, W2O Food Innovation, emphasized that “improved steviol glycosides technologies beget



Sweet Solutions

Our growing portfolio of organic and non-GMO sweeteners provides mild sweetness and major function in applications from cereals to snacks to frozen desserts and beyond. Let us help you create winning consumer products with label-friendly sweeteners that are simple and recognizable.

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- Tapioca Maltodextrin
- Tapioca Syrup Solids

LIQUID

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- Rice Syrup, Brown *New!*
- Rice Syrup, Clarified *New!*
- Tapioca Syrup
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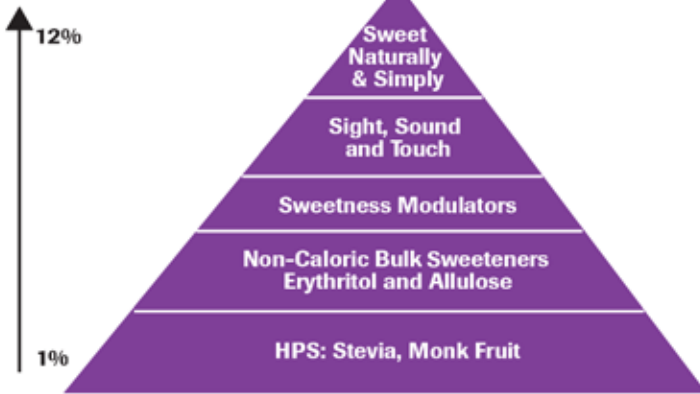
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C I R A N D A

Stacking Strategies for a Beverage (12% Sucrose Level Sweetness)

Sugar Equivalence



SOURCE: W2O FOOD INNOVATION/2018 SWEETENER SYSTEMS CONFERENCE

Stacking presents a systematic approach to meet or exceed a sweetness equivalency target of 12% sugar solutions in beverages, using available non-caloric sweetener technologies and sensory modulators, while staying below off-flavor thresholds.

better sweetener strategies.” In speaking about the chemistry and application of high-potency sweetener ingredients for foods and beverages, Woo pointed out in his characteristic trademark clarity and wit, that the big drive today is to develop “natural” sources for high-potency sweeteners that offer superior performance.

Factors that affect the function of various steviol glycosides include purity and chemical structure, which affect taste, solubility and sweetness intensity. “Natural stevia leaf contains anywhere from 40 to 70 identified steviol glycosides,” said Woo, “of which 11 have thus far been food-approved.” Each of the 11 may bind to different locations within the Venus Fly Trap part of the sweet-taste receptor, which “helps explain why they all taste different from one another.” It also explains why they can also taste better together in unique combinations.

Steviol glycosides (i.e., stevioside and rebaudiosides) consist of a central “steviol” alcohol ring structure to which multiple and different types of sugars are attached. These sugar side chains determine the taste and solubility properties of the different steviol glycosides—the more soluble the molecule, the more rapid the sweetness onset and clearance.

Highly water-soluble erythritol has quick onset which, together with steviol glycosides’ slow onset, delivers an overall sugar-like quick sweetness onset perception. An osmolyte, such as table salt, decreases steviol glycosides’ sweetness lingering via osmotic pressure change, said Woo.

Rebaudioside A (REBA), the most common steviol glycoside in commercial use, consists of four glucose units and is about

200x sweeter than sucrose. Its available purity in the marketplace ranges from 40% (REBA40) to 100% (REBA100).

Second-generation stevia is all about REBA. The higher the purity, the better the taste. However, REBA itself at high usage is still bitter, because it triggers two out of the 25 bitterness receptors: TAS2R4 and TAS2R14. REBB, with one less glucose side chain, is less sweet but also less bitter than REBA. Combinations of A and B have complementary (but not proven synergistic) effects on sweetness. At the far end of spectrum is “the famous REBM, the biggest steviol glycoside,” with six attached glucose units. “It is the best-tasting and the sweetest of the steviol glycosides, so far,” explained Woo. Farm-based third-generation stevia extracts are the newer 2-way and 3-way blends of REBA, B, C, D and/or M for even more sugar-like taste but at higher cost, he added.

How can steviol glycosides be improved? One approach underway is to breed stevia varieties with elevated levels of REBM (for the optimum profile) or REBC (for increased sweetness). Another is to use “natural” enzymatic glycosylation (“bioconversion”) of REBA to generate REBM. A third approach is to use “natural” microbial fermentation to convert corn glucose or sugarcane sucrose to REBM. Fermentation and bioconversion-based stevia already co-exist with farm-based stevia in 2018.

“The acceptable cost of high-potency sweeteners will vary according to their application and consumer expectations,” said Woo. He presented a matrix that cross-compares different stevia purity and moiety combinations whereby to achieve acceptable cost benchmarks, depending upon the food and beverage applications.

Another factor is the use of flavor compounds to enhance the performance of high-potency sweeteners. Woo explained how enzymatic glycosylation of REBA can be used to transform stevia extract into a sweetness-enhancing natural flavor with modifying properties (FMP) called glucosyl steviol glycosides (GSG). Using a GSG FEMA 4728 at up to 175ppm in a beverage would qualify it as a flavor, according to Flavor Extract Manufacturers Association (FEMA) criteria. Native stevia extracts, such as REBA60 and REBA80, also qualify as natural flavors, when used below 30ppm and 35ppm, respectively.

Woo is a big advocate of using stacking strategies to achieve desirable sweetness profiles. Stacking is a sugar-reduction strategy for building up to the required sweetness intensity and profile,

while staying below the off-flavor thresholds for all the plant-based ingredients used.

“Here is how one can achieve a targeted 12% sucrose equivalence of sweetness (12°Brix) for a beverage,” said Woo. Referring to the cost matrix provided earlier in the presentation, Woo started with 300ppm of an optimized steviol glycoside blend designed for sugar free to achieve 7°–8°Brix. Adding 100ppm of a high-purity mogroside from monk fruit, such as Mogrosides-V 55%, and either 1% erythritol or 2% allulose (both can be labeled as natural flavor below their FEMA limits) added another 2° Brix.

Also, mentioned Woo, one can use all five senses to enhance sweetness perceptions, including product packaging or immediate environmental smell, sight, sound and touch. “Together, these cross-modal interactions allow one to arrive at the final goal of 12°Brix or even higher,” said Woo.

Thus, strategy combined with technology may yet provide the solution to using high-potency sweeteners at optimum sensory performance and cost.

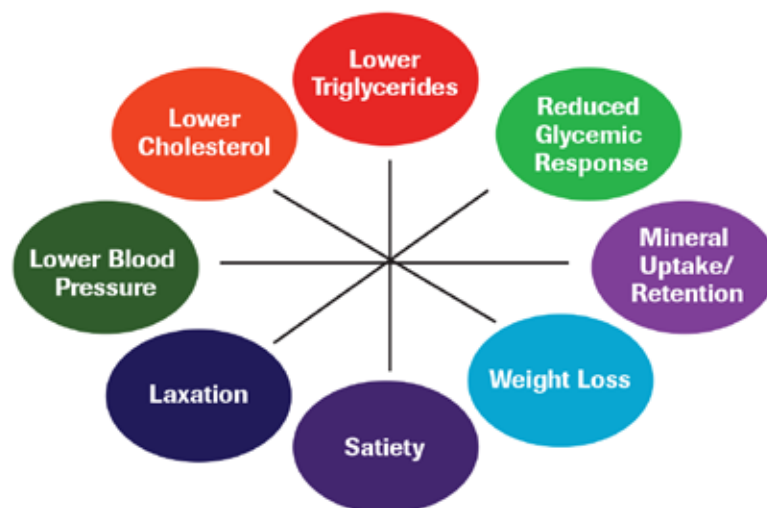
“3rd Generation Stevia Extracts: Neuroscience, Ingredient Technologies and Food Applications,” Alex Woo, Ph.D., CEO & Founder, W2O Food Innovation

Analytical Methods for Lawful Sweetener Labeling

THE REVISED U.S. NUTRITION LABEL regulations, to be implemented in 2020, will transform the carbohydrate portion of the label by including a line for added sugars along with revised definitions of dietary fiber. The food and beverage analysis industries are far from ready to accommodate these changes, explained David Plank, Ph.D., Managing Principal, WRSS Food & Nutrition Insights and Senior Research Fellow at the University of Minnesota, in his presentation, “Analytical Methods for Walking on the Lawful Side of Sugars, Dietary Fiber and Bioactive Sweeteners.”

“The FDA stated goals behind the regulatory changes are both to increase nutrition label transparency for consumers and to improve the health of the U.S. population via weight maintenance and a reduction in cardiovascular disease risks through reduced sugar consumption,” said Plank. The FDA’s goal for dietary fibers

Physiological Health Benefits Associated with Isolated & Synthetic NDC



SOURCE: ©2018 WRSS FOOD & NUTRITION INSIGHTS/2018 SWEETENER SYSTEMS CONFERENCE

🍌 **FDA’s new definition of dietary fiber includes two classes: 1. Non-digestible carbohydrates (NDC), both soluble and insoluble, and lignin that are “intrinsic and intact” in plants; and 2. “isolated or synthetic” NDC determined by FDA to have physiological effects that are beneficial to human health, such as those noted above.**

is transparency in order to erase the concept of “fake fiber” from nutrition labels. The objective now is to increase the consumption of “whole-grain, whole-food” fibers.

In regard to American food and beverage companies, the incentives are not just to avoid the wrath of the FDA for regulatory non-compliance, but also to avoid class-action lawsuits that will be brought whenever plaintiffs believe that they can demonstrate that food and beverage manufacturers have misled the “average” consumer. “Lawyers and consumers are always looking for a pay-day because they know that, in most cases, class-action lawsuits never go to trial but are settled out of court,” said Plank.

One of the potential warning signs should be if a formulation or label claim goes counter to the intent of the regulation, said Plank. He cited, as an example, a company adding a resistant starch to increase a product’s dietary fiber nutrition label declaration while also adding an amylase enzyme to digest the dietary fiber into glucose in order to increase sweetness. “Technically, it may be compliant with the letter of the regulations, but you will have violated the intent,” said Plank.

Plank identified two essential elements of the pending nutritional labeling regulations. The first element is that the label requires that all added mono- and disaccharides must be listed as “Added Sugars,” whether digestible or not. Thus, allulose and tagatose, which each contribute zero calories per gram, must be designated as “added sugars.”

“Allulose, a monosaccharide, registers 0-0.4 Kcal/g and also inhibits intestinal alpha-glucosidase, the enzyme that digests starch in the small intestine. Thus, not only is it non-caloric, it actually contributes the physiological benefits of a fiber through its action on reduced-starch digestion and concomitant reduced glycemic response,” said Plank. Even so, by the new regulations and existing current regulations, this physiological beneficial non-digestible carbohydrate must be labeled as added sugar, because it is a monosaccharide with less than a degree of polymerization (DP) of 3.

The second element is that none of the existing AOAC-approved dietary fiber analytical methods determine dietary fiber under the new regulations: They only measure non-digestible carbohydrates (NDC). However, when the existing AOAC-approved methods are used for determining insoluble and soluble NDCs in accordance with the new regulations, then a food manufacturer may claim zero calories per gram for the content of insoluble NDCs and 2 calories per gram for soluble NDCs on their food label—even if the NDCs do not physiologically qualify as dietary fiber. So, the determination of NDC content by these traditional AOAC analytical methods still has a practical benefit for those food manufacturers looking to make a low-caloric content product.

There are no analytical methodologies that can determine dietary fiber or added sugar as defined by the new regulations. As a result, food manufacturers are required to keep records of their food product formulations to support their nutrition label claims. FDA allows significant flexibility in how these records are constructed but does require them to be available for audit and maintained for a minimum of two years, post production.

The food analysis industry is hustling to catch up to the pending realities and liabilities of nutritional labeling compliance in 2020. They still have a long way to go.

“Analytical Methods for Walking on the Lawful Side of Sugars, Dietary Fiber and Bioactive Sweeteners,” David Plank, Ph.D., Managing Principal, WRSS Food & Nutrition Insights and Senior Fellow Researcher, University of Minnesota

Five Recommendations for Sugar-Reduced Baked Products

HOW DOES ONE REDUCE THE SUGAR content of products defined by their sugar content? Melanie Goulson, MSc, General Manager, Merlin Development and Adjunct Professor, St. Catherine University, provided some potential solutions to this dilemma in

her presentation, “Five Tips for Reducing Sugars in Bars and Baked Goods.” Goulson began by noting that the chocolate-chip cookie, an American bakery icon, contains 11g of sugar per 33g serving. “We can see that baked products and cereal and protein bars that we know and love generally consist of about one-third sugar. Endeavoring to replace that sugar represents a monumental task.”

Monumental, perhaps, but for the baking industry, such a task may be a defensive necessity. The challenge is that sugar contributes not just sweetness, but also bulking, functionality, yeast food, flavor, color, solubility, preservation, texture and viscosity to baked products. Then there are additional criteria to be met, such as meeting marketing goals regarding sugar-type content, clean labels and extended shelf life.

Goulson laid out a systematic approach to sugar reduction with five recommendations: The first is to “intimately familiarize oneself with the properties of all non-nutritive sweetener candidates.” These include bulking agents, such as erythritol, maltitol or allulose, typically used as a 1:1 replacement for sugar; and high-potency sweeteners, such as heat-stable sucralose or acesulfame-K and natural stevia or monk fruit-derived sweeteners, which are used at very low parts per million levels.

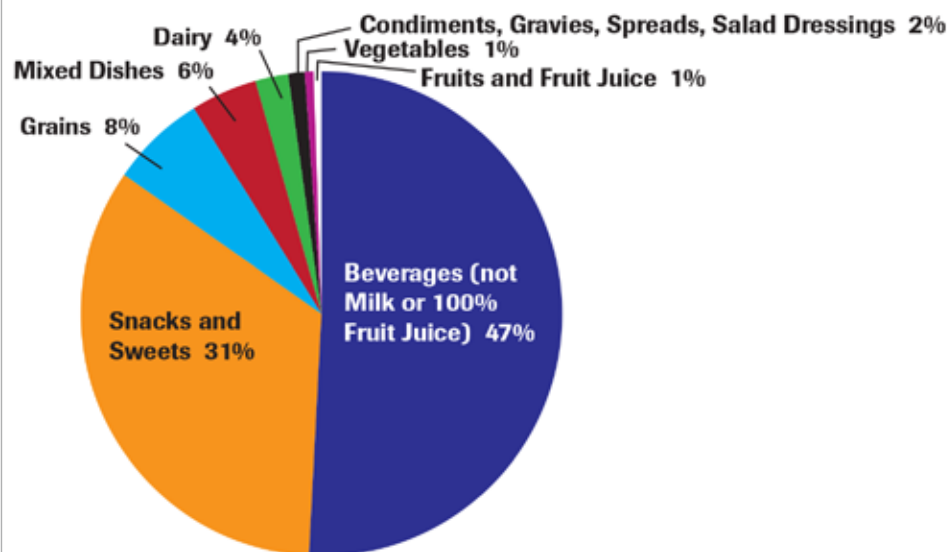
The second recommendation is to use sweetener blends. “Blending allows one to maximize sweetness, mitigate off-flavors; improve the temporal dynamics of sweet-taste perception; and leverage sweetness synergies.” Also, importantly, she strongly recommended that product developers “take every gram of sugar that you can get. If marketing is willing to accept one or two grams of sugar on the label, take it and run.” Even a very small amount of sucrose can speed up sweetness onset and round out the taste profile.

The third recommendation is to become intimately acquainted with all available bulking agents. Caloric bulking agents include maltodextrin, proteins, sucromalt and isomaltulose, for example. Low and no-calorie bulking agents may consist of sugar alcohols (e.g., maltitol and erythritol); fiber and fiber syrups (e.g., inulin, tapioca fiber); and resistant maltodextrin.

“In my own experience, I have observed very good results using chicory root fiber and erythritol for bulking (to achieve) 50%-or-greater sucrose reductions in cupcakes or cookies. A blend of inulin and erythritol combined with stevia glycosides can develop a nice, natural-label sugar replacement system.” Blends of polydextrose, acesulfame-k and sucralose can often be cost-effective, and sometimes, maltitol alone can be sufficient for bulking and sweetening in baked goods, “as long as browning is not a strict requirement,” Goulson added.

The fourth recommendation is to carefully manage texture, “which is critical to consumer acceptability,” explained Goulson.

Sources of Added Sugar in the Diet of Americans



SOURCE: DIETARY GUIDELINES FOR AMERICANS 2015-2020/2018 SWEETENER SYSTEMS CONFERENCE

🍯 **Sweet bakery products should be a major focus of sugar-reduction efforts, according to the most-recently issued U.S. Dietary Guidelines.**

Sugar plays many roles in texture. It can be important for aeration during mixing (cakes); for tenderization; and for controlling the rate of gluten formation. Other steps one can do to offset the textural impact of sugar reduction are to use flour with less protein; increase fat content (to prevent full gluten development); use emulsifiers (lecithin, egg yolk); reduce mixing; and manage moisture with soluble fiber, glycerol and other small molecular-weight ingredients.

As a fifth recommendation—regarding cereal and protein bars in particular, Goulson professed great satisfaction with using dietary fiber syrups, such as inulin, tapioca and corn syrups. She recommended paying close attention to the molecular chain lengths of the syrups and to be aware of potential digestive tolerance issues.

Can such products ever hope to meet consumer expectations? “It’s a steep challenge to replace 100% of the sugar in baked goods and bars and fully duplicate a full-sugar version,” Goulson replied. “But by using ingredient systems to replace all of the taste and functionality of sugar, you can make very good products.”

“Five Tips for Reducing Sugars in Bars and Baked Goods,” *Melanie Goulson, MSc, General Manager, Merlin Development and Adjunct Professor, St. Catherine University*

Tips for Reducing Sugar in Frozen Dairy Desserts

AS WITH BAKERY PRODUCTS, sugar’s most critical role is to control the texture of frozen dairy and frozen novelty products, began Jon Hopkinson, Ph.D., a technology consultant specializing in frozen desserts, in his presentation titled “Tips for Reducing Sugar in Frozen Dairy and Novelty Products.” It does so by managing water.

Sugar plays a crucial function in both ice cream-type desserts that are frozen while stirred, and quiescently frozen desserts, which are usually frozen in molds. First, it controls the freezing and melting characteristics of these products. It also contributes sweetness, viscosity, color and secondary flavors, such as browning flavors developed during pasteurization.

“Sugars are the most important control variables to determine proper freezing properties of mixes during processing,” explained Hopkinson. “Freezing-point functionality must somehow be compensated for when sugars are taken out of the formula.” Shelflife is affected by sugar’s effect on product melting point,



🍯 **Although sugar, with its multifunctional properties, plays a key role in ice cream and frozen novelties, several strategies can be used to achieve quality reduced-sugar frozen desserts.**

sugar migration and freeze-thaw recrystallization properties. For example, sugars can migrate and recrystallize on the surface of ice-pops, creating little round “cancer spots” on the surface during freeze-thaw cycles.

Colligative properties like freezing point are determined by the number of molecules (particles) per fixed unit of weight. Small molecular weight ingredients, like monosaccharides, contribute more particles per gram than disaccharides, and therefore have a greater effect on freezing point depression. The molecular weight of sucrose is 342; for glucose and fructose it is 180; and for erythritol, it is 122. Thus, selecting sucrose substitutes based on their molecular weights can help control freeze-point depression.

So, what if the goal is to reduce the sugar content in a gelato, sorbet or ice cream product by 50%, asked Hopkinson? He presented some strategies, with the caveat that one should carefully check the patent literature before mapping out a product development strategy.

One can hypothetically replace some or all the sugar with sugar alcohols (e.g., sorbitol), but their negative effects on digestive wellbeing at higher concentrations merit careful consideration. Erythritol, on the other hand, does not have the digestive liabilities of sugar alcohols, noted Hopkinson. “In fact, one can get away with 1:1 substitution of sugar with erythritol while keeping sweetness constant, cost permitting. However, you may also need to add additional bulking agents in order to control the amount of water available to freeze.”

A second strategy is to replace some of the sucrose with lower-molecular weight ingredients. For example, one can use combinations of erythritol, glycerol and fructose, with a sweetness boost from high-potency sweeteners, such as acesulfame-K or natural stevia.

A third strategy for frozen dairy desserts is to remove lactose (a disaccharide) by ultra-filtration and add-back monosaccharides, such as glucose and fructose. This could be expensive, so another alternative might be to treat the milk with lactase enzyme, converting lactose to the monosaccharides, glucose and galactose. Hopkinson warned that there may be a patent issue here as well.

A fourth strategy would be to replace sugar with a fruit juice and bulking agent. However clean-sounding the juice component, this will likely require adding additional bulking agents with complex-sounding names (e.g., maltodextrin, erythritol). Under the pending nutrition labeling regulations, juice concentrates will need to be factored in as an *Added Sugar* on the nutrition label. “Trying to achieve an ‘all juice’ claim for a frozen dessert can be a regulatory nightmare, as most single-strength

juices don’t contain enough sugar to meet processing, taste and product-quality requirements,” warned Hopkinson.

And, finally, “one can just remove a portion of the sugar from a formula and leave it at that,” concluded Hopkinson. “Quality won’t be as good, but at-least some consumers may be willing to accept the trade-off in the interest of reduced sugar and calories.” He finished his presentation by illustrating the very long and complex ingredient statements from some mainstream frozen desserts with low sucrose or no sucrose, showing that there is much room for improvement.

*“Tips for Reducing Sugar in Frozen Dairy and Novelty Products,”
Jon Hopkinson, Ph.D., technology consultant specializing in
frozen desserts*

Sweetener Systems and Sensory: Three Practical Tools

THE MARCH TOWARD HEALTHIER reduced-sugar product formulations may break new ground in the art and science of food formulation, but it will not necessarily break new ground regarding consumers’ expectations for the sensory qualities of their food and beverage choices. Hence, a consistent sensory evaluation protocol should be an essential adjunct to any sugar-reduction project.

Judy Lindsey, General Manager of the Brisan Group, broke down such a sensory evaluation protocol into three basic elements in her presentation, “Sweetener Systems and Sensory: Three Practical Tools to Help You be More Agile.” The first is to build a proper lexicon for use as a consistent basis of comparisons. The second is to develop the proper methodologies whereby to compare sensory properties and their deviations from development targets. A third is to properly understand consumer sensory priorities. “These three elements provide the foundations for building agile sensory programs that will allow developers to obtain results faster and with greater confidence,” said Lindsey.

Why does one need a lexicon? “It is important that new product development teams share the same terminology and thereby waste less time arguing about flavor perceptions,” said Lindsey. “The same lexicon should be employed by all different levels, be it by the technical team, the sales team or the management team.” For example, descriptors, such as “metallic,” “acidic” and “bitter” can overlap, but still describe distinctly different sensory experiences. Some descriptors, such as “stale,” can refer to flavor, texture or both.

Example of a Cookie Lexicon

Sweetness = Basic taste

Cocoa = Unsweetened, powdered cocoa flavor

Chemical = Flavor associated with petroleum-based chemicals

Anise = Flavor associated with black licorice

Crisp = Sharpness of fracture during first bite

Sandy = Presence of small particulates as product breaks down

SOURCE: BRISAN GROUP/2018 SWEETENER SYSTEMS CONFERENCE



“Use the lexicon terminology from the very beginning of the project and make sure that these words are the only ones used to describe the products in question. As new sensory observations are made about a product, add them to the lexicon,” said Lindsey. “But, if additional words come up to describe already-observed sensory attributes, strike their use and revert to the original lexicon,” she added.

“Constantly revisit the lexicon and keep it simple,” emphasized Lindsey.

In response to an audience question, Lindsey also recommended that development teams establish reference samples for each term included in a lexicon for training purposes. This will provide continuity between different projects and development teams.

Once you have a lexicon, you need methods that can compare and contrast one sample against another during the product development process. This requires having a consistent and accurate sensory protocol readily available in order to prevent time wastage. “The methodology should be systematic, simplistic and utilized in a uniform manner, always using the same forms,” said Lindsey. Potential sensory survey tools include: 1) flash profiling; 2) Difference from Control (DOC) methodology; and 3) using a “descriptive panel flight team.”

As an example of a flash profile-evaluation form, Lindsey displayed a survey form that quantified each attribute in the company’s lexicon on a 10-point scale. “Deviations from control” can be measured on a 9-point scale measuring less-than and more-than the control value. [See slide 8 of Lindsey’s presentation at <https://bit.ly/2AzrOVg>].

A “descriptive flight team” refers to a small, dedicated sub-group of the company’s descriptive sensory panel who are assigned to accompany product developers for the length of the project. “This can be done at less cost and less time than employing a full-descriptive panel along the way,” explained Lindsey.

Such are the tools of an ongoing sensory analysis program. Other “need to know” project requirements are the boundaries of consumers’ sensory expectations for products. It is important to know just how much wiggle room one has in the inevitable redesigns of product sensory profiles that accompany sugar reduction, Lindsey noted.

“For example, if one is worried about a detected ‘artificial taste,’ and it emerges that most consumers cannot perceive it, then perhaps it should not be of concern,” she explained. “Also, when consumers evaluate a reduced-sugar ice cream, do they compare it to a high-end, high-fat ice cream or do they compare it to lower-end brands?” Product developers should know the answers to such questions before they embark on a project.

Lindsey suggested that much of this consumer preference information is likely available in company marketing data, published literature or in third party research available on the internet. It always pays to do one’s sensory homework, in other words.

“Sweetener Systems and Sensory: Three Practical Tools to Help You be More Agile,” Judy Lindsey, General Manager Brisan Group

The Global Food Forums staff thanks attendees, speakers, sponsors and exhibitors at this event for making it a success. We are pleased to announce the next Sweetener Systems Conference will be held March 24, 2020, followed immediately by the 2020 Clean Label Conference on March 25-26, 2020.

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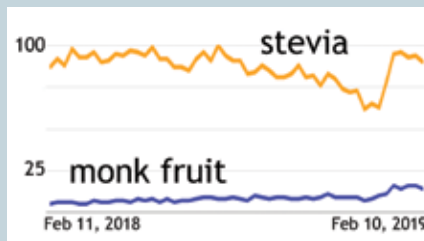
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Monk Fruit, Stevia and Google Trends

In the last 12 months (ending February 10, 2019), Google Trends shows that interest in monk fruit (as shown by the percent the term is used in Google searches) has been trending up. Although there was a dip in stevia searches

Google explains that "Numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular." One explanation of Google Trends analysis can be found at <https://bit.ly/2RYTFDR>

SOURCE: GOOGLE TRENDS, FEB. 2, 2019 / GLOBAL FOOD FORUMS, INC.

late 2018, interest has been holding somewhat steady, as per the chart. On a regional comparison basis, interest in stevia has been relatively greatest in Peru, followed by Chile, Uruguay, Paraguay and Portugal with the U.S. following at a lower percent. In contrast, interest in monk fruit, as determined by percent of searches, was the greatest in Thailand, followed by the U.S., Puerto Rico, Hong Kong and Canada. Google notes that in the U.S., searches trending up that are related to stevia include "does stevia break a fast" and "is stevia ok on keto."

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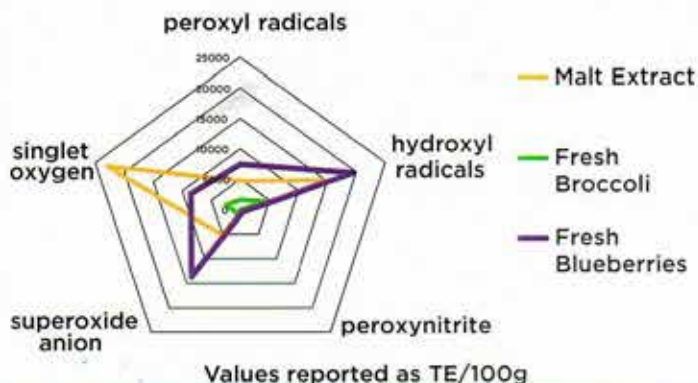
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