2022 Clean Label Conference

"Sophisticated Solutions for Simplified Products"

What's Inside on Clean Labels…

- Navigating the Evolution of Clean Eating for Better Innovation
- Opportunities & Challenges from Innovative Products and Claims
- Powering the Evolution of Fermentation Processing
- Technical Strategies Offset Hydrocolloid Supply Chain Challenges
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  - Clean Labels & Sustainable Food Systems: A Food Scientist's Role
- Clean Label Ingredient Vendor Profiles

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2022 Clean Label Conference Magazine

Sophisticated Solutions for Simplified Products

The 2022 Clean Label Conference, held on May 24-25 in the Chicago area, ended a three-year, Covid-triggered hiatus of Global Food Forums' in-person conferences. In that period, trends evolved. Consumer surveys showed increased interest in sustainability, clean eating, plant-based diets and proteins. All are included under the clean label umbrella and covered in the conference.

The information needs of formulators and other product developers continued to be a core focus. Presentations related to sugar reduction and labeling, technical properties of colorants and flavorings were on the agenda, as were emerging fermentation technologies, hydrocolloid properties (with relevance to supply chain issues) and sodium reduction.

The program, with links to many PDFs of the PowerPoint presentations, can be found at https://cleanlabel.globalfoodforums.com/clean-label-events/2022-clean-label-conference/.

The 2023 Clean Label Conference is scheduled for May 23-24 in the Chicago area. Information will be posted https://cleanlabel.globalfoodforums.com/2023-clean-label-conference-overview/. Please join us!

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

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On May 23-24, 2022, the Clean Label Conference returned to an in-person format. Breakout sessions, tabletop exhibits and breaks offered networking opportunities.

Although the event's presentations were the seminar's big draw, informal conversations between speakers and attendees were a useful avenue to catch up on industry trends.

Clean Eating Impacts Manufacturers' Ingredient Decisions

THE THEME FOR GLOBAL FOOD FORUMS' 2022 CLEAN LABEL CONFERENCE was set with the keynote presentation, "Unpacking the Ever-Evolving Narrative of Clean Eating in Order to Inform Innovation," by Rachel Cheatham, Ph.D., Founder & CEO, Foodscape Group, LLC. Her talk provided a consumer and marketplace perspective on clean labels and guidance in navigating the movement's continuous evolution.

Consumer awareness of clean labels began in the 1960s, with work citing a correlation between high-fructose corn syrup (HFSC) and obesity—yet subsequent data showed a decline in caloric sweetener usage with increasing obesity. The authors of the original paper twice tried to retract the hypothesis.

In the 1980s, a change in regulations became the catalyst for the negative focus on additives. Each additive in the ingredient list must be declared on a pre-packed food label. Up to that time, additives were declared using general groupings that reflected their functions in the food, such as preservatives, antioxidants and colors.

"These new labeling regulations brought in some lengthy lists of chemical names and a new E-numbering system (in Europe), which was intended to make it easier to identify additives," stated Cheatham, "and to inform consumers that the additive was safe for use."

CONSUMER CONFUSION AND PERCEPTION

Consumer distrust was fueled by many passionate articles in the tabloid press on the "harmful" effects of all "chemical" additives, which were blamed for various adverse health effects. A positive outcome of this anti-additive campaign was that food manufacturers scrutinized their use of additives to eliminate or minimize their use.

Although meant to protect people with sensitivities, E-numbers have been controversial. For example, the European Food Safety Authority (EFSA) concluded that titanium dioxide was not considered safe when used as a food additive, leading to a unanimous agreement by EU member states in October 2021. However, in the U.S., the additive is considered safe.

"The trickle-down effect from policymakers to traditional and social media led to consumers questioning whether scientists know what they are doing," noted Cheatham. "Often, these ingredient-level inconsistencies of being approved or disapproved for use further fuel the global clean label debate."

Select retailers are identifying unacceptable ingredients. Whole Foods lists 230+ banned ingredients, including FD&C colors, calcium disodium EDTA, partially hydrogenated oil, DATEM, CBD/cannabidiol, *Ginkgo biloba*, soy leghemoglobin, hijiki and insect flour.

"The list is quite lengthy, and yet, we can't say for sure why certain ingredients are on the list. There isn't a lot of substantiation or reason provided. Nonetheless, this is the list brands must abide by, if they want to be cleared for sales at this retailer," observed Cheatham.

Fast-forward to 2019 and the development of the NOVA system, in which foods and beverages are grouped into one of four categories. Ultra-processed foods (UPFs) are coming under increased scrutiny. UPFs, which did not exist before the mid-20th century beyond a few products, now account for 59% of the total calories consumed in the U.S. (See chart "What Are Ultra-Processed Foods?") [Global Food Research Program, https://bit.ly/3y8eLGY].

There has been increasing peer-reviewed research focused on UPFs in the last decade, with some publications reporting higher consumption of calories from UPFs attributable to the hyper-palatability of the ingredient formulations.

Cheatham cited a meta-analysis of close to six million participants where the highest consumption of UPFs was associated with increased mortality risk. However, breakfast cereals, considered UPF, are associated with lower mortality risk (Taneri, PE, et al. *Am J Epidemiol*. 2022/https://bit.ly/3ONvUwT).

NOVA: What Are Ultra-Processed Foods?

GROUP 1	GROUP 2	GROUP 3	GROUP 4
Unprocessed/minimally processed	**Processed culinary ingredients**	**Processed foods**	**Ultra-processed foods**
Foods unaltered or altered by processes such as removing inedible parts, drying, grinding, cooking, pasteurization, freezing, or non-alcoholic fermentation. No substances are added. Processing aims to increase food stability and enable easier or more diverse preparation.	Substances obtained directly from Group 1 foods or from nature, created by industrial processes such as pressing, centrifuging, refining, extracting or mining. Processing aims to create products to be used in preparation, seasoning and cooking of Group 1 foods.	Products made by adding edible substances from Group 2 to Group 1 foods using preservation methods such as non-alcoholic fermentation, canning, or bottling. Processing aims to increase stability and durability of Group 1 foods and to make them more enjoyable.	Formulations of low-cost substances derived from Group 1 foods with little to no whole foods; always contain edible substances not used in home kitchens (e.g., protein isolates) and/or cosmetic additives (e.g., flavors, colors, emulsifiers). Processing involves multiple steps and industries and aims to create products liable to replace all other NOVA groups.

SOURCE: GLOBAL FOOD RESEARCH PROGRAM, UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL, HTTPS://BIT.LY/3Y8ELGY /2022 CLEAN LABEL CONFERENCE
NOTE: VERBIAGE UNEDITED FROM THE CHART PUBLISHED ONLINE.

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Products meeting a clean label standard can be 10 times as expensive as their traditional counterparts. Photo credit: BearFotos/Shutterstock.com

"The Dietary Guidelines for Americans, 2025-2030 Proposed Scientific Questions" included the following, suggesting how nutrition scientists and policymakers view UPF: "What is the relationship between consumption of dietary patterns with varying amounts of ultra-processed foods and growth, size, body composition, risk of overweight and obesity, and weight loss and maintenance?"

Consumer data from the 2022 International Food Information Council (IFIC) shows that clean eating is a primary focus, with nearly half of so-called "clean eaters" defining the term as not heavily processed, fresh products, organic and with simple ingredient lists. (IFIC, 2022/ https://bit.ly/3bPcKIg)

PRODUCT MESSAGING

Ingredients targeting functional (calming, focus, energy, etc.), natural flavors, non-GMO and environmental messaging are increasing. For the latter, it may be difficult to be clean label and animal-free, as precision fermentation—a technology used to produce non-animal whey protein, among other ingredients—is seen as bioengineering.

Products meeting a clean label standard can be 10 times as expensive as their traditional counterparts. Consider the case of a tomato ketchup sold at a major discount retailer at $3.29 without HFCS vs. $0.99 (per 20oz) for the regular. "Within any mass-market food or beverage category, there will be a continuum of options that range in price. Often 'cleaner label' products, even if based only on perceptions, are the pricier ones. It's up to each consumer to decide what's worth spending extra for," stated Cheatham.

Clean label product development will depend upon retailers and end-consumers' desires for affordability. Every ingredient needs to be examined to ensure sustainable sourcing, purposeful processing and functional properties.

"All these considerations will come into decisions as to which ingredients are being used in our foods and beverages, with the hope that we don't confuse consumers. We do not need any additional actual or perceived hurdles to consuming a safe, nutritious and affordable diet," concluded Cheatham.

"Unpacking the Ever-Evolving Narrative of Clean Eating in Order to Inform Innovation," Rachel Cheatham, Ph.D., Founder & CEO, Foodscape Group, LLC

Creating "Clean Labels:" Not a Clean Process

WHILE THE CLEAN LABEL CONCEPT is hot and trendy, it is not officially defined by any government agency, leaving it open to interpretation. Clean label claims can range from express statements, such as "nothing fake" to implied claims like "small batch," to lists of ingredients that a food product is "free from," among others. Claims include more than just the text on a label, such as images and graphic designs. These varied approaches and interpretations of claims make it difficult to answer the question, "what, exactly, is a 'clean' label?"

"When advising clients, lawyers must consider consumer expectations," said Chip English, Partner-in-Charge of the Washington D.C. office of Davis Wright Tremaine. His presentation, "Clean Label Opportunities & Challenges Arising from Innovative Products and Claims," was given at Global Food Forums' 2022 Clean Label Conference.

Food is considered misbranded (in violation of federal law) if its labeling is false or misleading. All claims must be truthful, not misleading and substantiated. Advertisers are responsible for substantiating all reasonable interpretations of claims made—not just the meaning(s) they intend for the claim.

Even if a claim is true, it can still be misleading. FDA has defined some claims that fall under the clean label umbrella, but many are not defined. This creates challenges—and opportunities—for food companies in marketing and successfully selling the product, while minimizing legal risks.

Claims about nutrient content are one way food companies may create a clean label. However, disclaimers might be required, depending on the product's specific claim and nutrient profile. English used the FDA-defined claim "sugar-free" as an example. A company may want to state that its product is sugar-free and to keep the label design simple. But a disclaimer about calorie content will be required—either "not a low-calorie food" or "low

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calorie," depending on the product. This contrasts with the claim "healthy"—another FDA-defined nutrient content claim some include within the concept of clean label—which does not require that specific disclaimer.

"Healthy" is an implied nutrient content claim that can be used only if the product meets certain nutrient thresholds for fats, cholesterol and sodium (low in those); and specific vitamins and other so-called "good" nutrients (high in those). Even if a product meets the regulatory definition of healthy, other express or implied claims may result in an allegation that the product is not healthy—e.g., because of sugar content.

CLAIM CAVEATS

Claims that a product is "free of" particular nutrients, ingredients or substances are common ways companies convey that their products are clean. In these cases, companies should consider whether the food is 100% free of the identified substance (absent a defined claim allowing the presence of an insignificant amount) and whether being "free of" that substance is common to that food category.

For example, because FDA has not defined trans fat nutrient content claims, no claim characterizing the level is permitted (such as "low trans fat"). Moreover, any "zero trans fat" or "0g trans fat" claim made outside the Nutrition Facts Panel can present a risk if there is any trans fat in the product. English considers it a "twist of FDA law" that for some nutrients (including trans fat), one must round up or down the amount declared in the Nutrition Facts Panel—but not when the nutrient content claim is made outside of the Nutrition Facts Panel.

The claim of "no antibiotics" is another example. It is illegal to sell milk that contains antibiotics, so all milk must be antibiotic-free. Claiming that your milk contains no antibiotics, while true, can be misleading, because the claim is not unique to your product. This same rule applies to the nutrient content claim. If you want to claim that your broccoli is "fat-free," you need to include the disclosure "a fat-free food"—because all broccoli is fat-free.

Some companies may rely on organic claims to imply that their product is clean. English stressed that organic is a production method only and should not state or imply a "better-for-you" or "healthier" message. Further, English described the claim "natural" as "organic lite" and cautioned that the mere use of it, or claims of 100%, pure or "zero,"…"guarantee that product will be examined, and production or processing elements will be considered."

Finally, companies may point to their products' sustainability attributes as demonstrating that the product is clean. Addressing such "green claims," he noted that the Federal Trade Commission Green Guides are expected to be updated later this year, which

"How much risk are you willing to take? Natural claims aren't going away," says Chip English. "As soon as you use absolute terms, some lawyer or foundation will check."

he hopes will provide additional guidance on what is required to make a green claim. In addition, English expects additional guidance from USDA, FDA and state food agencies concerning the use of recycling and composting symbols and associated claims that vary from state to state.

REDUCING LEGAL RISK FROM LABEL CLAIMS

The main legal risks associated with label claims are government enforcement, consumer class action litigation and competitor false advertising litigation. Consumer class action litigation is the most significant and likely of those three. Large and small companies alike have been recipients of lawsuits on labeling issues, and labeling litigation can be expensive—regardless of the outcome.

Damages—what the company might owe to right the "wrong" caused by the allegedly mislabeled product—can be very expensive, but so are the legal fees and costs incurred in successfully defending a challenged label. A Honey-Nut Cheerios label claim that was challenged reveals there may be less liability risk when an established product changes its claims, because it might be harder for a consumer to prove that all consumers purchased the product in reliance on that new (challenged) claim. In that case, the defending company showed that, even if the claim was not true (and they asserted that it was true), the company had only recently started making the claim, and sales had not increased.

"I'm not saying it's risk-free, but there may be greater opportunities with less risk when claims are made for an established product vs. a new product," said English. "Emerging companies making their first product don't get to rely on consumers' estab-

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lished purchasing habits, so they have a somewhat greater risk." The problem is that a plaintiff in a lawsuit will likely assert that, without the improper claim, there would have been no sales of the product at all; and, without a sales history, one cannot make the "Honey-Nut Cheerios defense" work.

In light of these labeling risks, English recommends that companies have their labels reviewed early to identify and mitigate those risks.

"Clean Label Opportunities & Challenges Arising from Innovative Products and Claims," Chip English, Partner-in-Charge, Washington D.C. office of Davis Wright Tremaine

Fermentation Processing: Advances & Benefits

FERMENTATION HAS A LONG HISTORY, beginning with the spontaneous fermentation of dairy in North Africa in 10,000 BC. So began Paulo de Boer, Ph.D., Scientist and Project Manager, Wageningen Food & Biobased Research, in his Global Food Forums 2022 Clean Label Conference presentation titled "Powering the Evolution of Fermentation Processing." De Boer went on to discuss current and emerging applications.

There is a strong revival of interest in fermentation. This is partly because consumers perceive fermentation as natural; some fermentation products contain healthful probiotic cultures; and due to the popularity of home fermentation.

Technically, fermentation is the process of converting sugar into several components and releasing energy. This takes place in the absence of oxygen. Different types of fermentation are distinguished, e.g., lactic acid homo-fermentation, lactic acid hetero-fermentation (other acids produced) and alcohol fermentation. However, fermentation is a term widely used nowadays to describe processes involving microorganisms, irrespective of the presence of oxygen.

EVOLVING INDUSTRIAL FERMENTATION USES

Industrially, there are two major fermentation styles: submerged or liquid fermentation and solid-state fermentation (SSF). Mushrooms are an example of SSF. Soybeans can be fermented to create soy sauce, a liquid fermentation process. Fermentation is widely used to produce ethanol, enzymes, secondary metabolites (e.g., penicillin, statins), organic acids, flavors and amino acids.

Environmentally, fermentation is used for wastewater management, bioremediation and air filtration. Side streams of industrial processes can be used as substrates for further fermentation or production of biogas.

Food Fermentation

The current transition from animal to alternative protein sources poses many challenges for maintaining quality.
Plant-based protein sources:
- **Can lack essential vitamins**
- **Often have off-flavors**
- **Require many additions to obtain a tasty product**

(The long list of ingredients is a far cry from a clean label product…)

SOURCE: PAULO DE BOER, PH.D., WAGENINGEN FOOD & BIOBASED RESEARCH/2022 CLEAN LABEL CONFERENCE

Food fermentation can reduce the number of ingredients used in plant-based protein products.

In food, fermentation produces a wide range of products. Examples are provided below in the form of the production of flavors or low-caloric sweeteners. Moreover, precision fermentation is being explored to make alternatives for animal-derived proteins, such as casein. Fermentation can also be used for shelflife extension and production of vitamin B12, an essential vitamin lacking in plant-based foods.

Currently, many ingredients are used to improve the flavor of and mask plant-based foods' off-flavor. De Boer said that fermentation could enhance the quality of plant-based alternative protein sources using fewer ingredients.

For example, ingredients used in the production of plant-based yogurt are often associated with a beany flavor. The sources of this off-flavor are aldehydes and ketones. One way to remove off-flavor is to convert the aldehydes to alcohols. Soy yogurt base can be fermented to lower hexanal levels and to convert beany flavor to fruity flavor.

Vitamin B12 is an essential vitamin that is lacking in plant-based foods. Tempeh is produced by fermenting chickpeas with a fungus. Specific bacterial strains can be added to the fermentation to produce B12 at similar levels to meat products.

Stevia low-caloric sweeteners are derived from the plant Stevia rebaudiana. Various stevia glycosides [NOTE: In the U.S. FDA GRAS petition, the term "steviol glycosides" is used] are produced via precision fermentation using a modified yeast. The resulting sweetener is free of the production organisms, so it is GMO-free and can be labeled as "steviol glycosides."

Erythritol is a sugar alcohol with close to zero calories; it does not affect blood glucose or cause tooth decay. It has 60-70% of the sweetness of sucrose. The fermentation from glucose to erythritol may be done by *Moniliella pollinis* or *Yarrowia lipolytica* in highly osmotic media.

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Microbial biomass as a protein source is commonly referred to as mycoprotein. Quorn is a commercial brand of such a mycoprotein. Protein can be extracted from fungal biomass to produce meat alternatives; microbial biomass can also be used as a protein source. These microorganisms can also be grown on various side streams. The textural properties of such microorganisms can also be used to produce a microbial fabric, explained De Boer.

A major challenge in the current protein transition is that the novel plant-based substrates often have unwanted properties, such as undesirable flavor components. Fermentation is a desirable method to assist in the development of novel plant-based meat alternatives, but finding the best combination of microorganisms and substrates is difficult to predict. Therefore, efficient screening of microorganisms-substrates is necessary to develop products that taste similar to traditional food products cost-effectively.

Wageningen has developed a highly efficient screening platform, "MINIScreen," that is based on matrix interaction and can predict, design and develop natural solutions and optimal fermentation strategies. This platform allows the scientist to screen many more combinations than conventional screening, offered De Boer.

"Powering the Evolution of Fermentation Processing," Paulo de Boer, Ph.D., Scientist and Project Manager, Wageningen Food & Biobased Research [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/fermentation-processing-advances-benefits-presentation.]

Examples of Viscosifier Functionalities

Suspension	Emulsion Stabilizing	Protein Protection	Foam Stabilizing
Carrageenan	Gum acacia*	Pectin	Gelatin
Gellan gum (LA&HA)	Citrus fiber	CMC	MC/HP MC
Xanthan gum	PGA		MCC
Agar	Tamarind seed gum		Xanthan gum
Cellulose gel (MCC)	Beet pectin		

* SENEGAL TYPE
SOURCE: IMR INTERNATIONAL, NZALESNY@HYDROCOLLOID.COM/2022 CLEAN LABEL CONFERENCE

Examples of Gelling Hydrocolloid Multifunctionalities

Shear Reversible	Thermal Reversible	Thermal Irreversible	Thermal Gelation	Foam Stabilization
Carrageenan	Gelatin	Alginate w/Ca2+	MC/HPMC	Gelatin
Gellan gum	Carrageenan	Konjac		Carrageenan
Gelatin	Xanthan/LBG or tara	HM pectin		
LM pectin	LM pectin	Agar*		

* HIGH MELT TEMPERATURE
SOURCE: IMR INTERNATIONAL, NZALESNY@HYDROCOLLOID.COM/2022 CLEAN LABEL CONFERENCE

Technical Strategies Offset Hydrocolloid Supply Chain Challenges

THE CURRENT SUPPLY CHAIN DISRUPTION and instability make sourcing many hydrocolloids difficult. However, hydrocolloids possess a wide range of functionalities for food formulators in the clean label space. As such, it is nearly impossible to remove them altogether, said Nesha Zalesny, MBA, partner at IMR International*, a market research firm specializing in food hydrocolloids.

Zalesny presented a talk at Global Food Forums' 2022 Clean Label Conference titled "Understanding Hydrocolloid Properties to Tackle Supply Chain Instability." Understanding the current market and the basic properties of hydrocolloids can help formulators make better strategic decisions when formulating.

Hydrocolloids are long-chain polysaccharides generally comprised of a repeating backbone with side chains. The side chains can be a simple methoxy or carboxy group or could also be a single sugar or group of sugars. The exception would be gelatin, which is a protein. Understanding the origins of the hydrocolloid helps with grouping functionality and understanding the supply-chain disruptions currently affecting many ingredients.

SOURCE OF HYDROCOLLOIDS

There are six sources of hydrocolloids: biogums, cellulosics, exudates, plant/seed, seaweed and animal. Nearly every category is facing major supply chain disruptions. Increasing transportation, as well as energy and labor costs for all hydrocolloids, are forcing manufacturers to increase their prices.

Almost every hydrocolloid has seen at least double-digit price increases; some, like locust bean gum, tara gum and starches, have seen triple-digit price increases, noted Zalesny. Chinese hydrocolloid manufacturers face a double-energy control policy that limits the energy consumed and the intensity of use. This affects hydrocolloids, such as xanthan gum, and cellulosics, like CMC. Of all the hydrocolloids available, only pectin and guar are not experiencing significant instability [at the time of this presentation].

Zalesny offered the following advice for formulators: Source materials as they develop the product and pick the right tool for the job. If formulators work with purchasing agents to determine availability, they may eliminate problems in the long run. To choose the right tool, formulators should ask themselves what functionality is needed to bring the desired texture and stability to the product. Hydrocolloids can be loosely grouped as viscosifiers or gelling agents. Viscosifiers can be further broken into hydrocolloids that can suspend, stabilize emulsions, protect proteins and stabilize foam. (See chart "Examples of Viscosifier Functionalities.")

Most gelling hydrocolloids require a gelling cation, such as calcium, to be fully functional. Ensure that the proper amount of cations is added for full functionality of the hydrocolloid, advised Zalesny. Gelling hydrocolloids also have multiple functionalities. The gels themselves can be shear-reversible, thermal-reversible and thermal-gelling, and can stabilize foam. (See chart "Examples of Gelling Hydrocolloid Multifunctionalities.") Zalesny advised that these charts are not necessarily exhaustive lists but will hopefully assist formulators in getting started with a new texturizing agent.

HYDROCOLLOID REACTIONS

Zalesny also recommended taking advantage of synergistic reactions between hydrocolloids. Synergistic hydrocolloids can be blended to create novel textures or a viscosity higher than either single component. A blend of xanthan and locust bean gum is a great example. Xanthan or locust bean gum each adds viscosity to a food system. But, if blended at a 50:50 ratio and heated, they will form a gel. The galactomannans, such as locust bean gum or tara gum, are synergistic with several other hydrocolloids, like carrageenan or agar. When blended, these hydrocolloids will modify or strengthen gels. This property may enable formulators to reduce the total amount of hydrocolloid added to the formulation.

Finally, processing hydrocolloids properly is crucial to achieving full functionality. Most hydrocolloids are either hot- or cold-soluble. Cold-soluble hydrocolloids can be more challenging to work with on industrial-scale production lines. Adding a 50lb bag of xanthan gum directly to water will most likely result in industrial-sized lumps of unhydrated gum, Zalesny wryly pointed out.

Examples of hot-soluble hydrocolloids include agar, carrageenan, cassia, curdlan, gelatin, HA gellan, locust bean gum, pectin, starch and tara gum. Cold water-soluble hydrocolloids include

alginates, acacia gum, CMC, LA gellan*, guar gum*, MC/HPMC, microcrystalline cellulose, pectin*, starch (instant) and tara gum*. (*Zalesny noted that the asterisked ingredients had an additional requirement and/or heat application was helpful.)

Blend cold-soluble hydrocolloids with dispersing aids, such as sugar, salt or other dry ingredients. A simple rule of thumb is 10 parts dispersing agent to one part gum. If oil is available, hydrocolloids can be dispersed at five parts oil to one part gum.

The COVID-19 pandemic has caused a massive breakdown of the supply chain. Hydrocolloid users face shortages and delays. If strategies such as sourcing while developing a new formulation; picking the right tool for the job; processing correctly; optimizing use level; and using synergistic hydrocolloids are still needed, alternatives such as fibers may be helpful. Fibers sourced from citrus, seaweed flour or rice flours may aid formulators when dealing with shortages. Formulators should be aware that there are rarely drop-in solutions; long-term shelflife may be impacted; and cost-in-use will change.

"Understanding Hydrocolloid Properties to Tackle Supply Chain Instability," Nesha Zalesny, MBA, partner at IMR International, a market research firm specializing in food hydrocolloids [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/technical-strategies-offset-hydrocolloids-supply-challenges-presentation/.]

**IMR publishes a Quarterly Review of Hydrocolloids that offers current market data for all hydrocolloids from agar to xanthan gum. For more information, see https://www.hydrocolloid.com/*

The State of Natural Colorants

RESEARCH ON ENHANCING AND STABILIZING NATURAL COLORANTS shows that flavonoids are versatile compounds with a wide variety of uses. M. Mónica Giusti, Ph.D., Professor, Department of Food Science and Technology, The Ohio State University, described the state of natural colorants in her presentation titled "Natural Colorants: Challenges and Opportunities" at the Global Food Forums 2022 Clean Label Conference.

Consumers generally have a positive attitude towards natural colors and those from plant sources. However, it can be challenging to want products to "look right" while still wanting them to be natural. According to Giusti, part of the problem manifests in consumers wanting natural but having reservations about sources from insects, bacteria or GMOs.

Butterfly pea flower extract, FDA approved in October 2021, is an anthocyanin that gives a beautiful blue color at lower-than-expected pH levels. This natural blue colorant is ideal for lemonade, as adding citrus juice (further lowering the pH) gives it a pink color. [Speaker Mónica Giusti is shown in the photo.] Source: M. Mónica Giusti, Ph.D., The Ohio State University & Fellow of the National Academy of Inventors/2022 Clean Label Conference

COLORANT COMPLEXITIES

Switching to natural colorants involves determining the appropriate color for your product, your target market and staying within regulatory restrictions in various countries. Some companies want a "universal" product that will give the same color in all applications. This is practically impossible due to different colors being expressed, depending upon various chemical properties of the product and its environmental factors—such as temperature, light and the presence of oxygen.

Five of the 30 colorants exempted from FDA Certification (e.g., FD&C colorants) and approved for human consumption were added to the list as recently as 2000. These colorants include butterfly pea flower extract, lycopene tomato extract or concentrate, mica-based pearlescent pigments, soy leghemoglobin, spirulina and sodium copper chlorophyllin.

Soy leghemoglobin, for instance, turns a reddish-brown color when cooked and is used in plant-based meat applications. It is the vegetable equivalent of meat myoglobin and is produced using genetically modified yeast, noted Giusti.

Anthocyanins are found in various fruits and vegetables, including raspberries, pomegranates, berries and grapes. The basic unit of anthocyanins is a multi-ring chemical structure typically linked to sugars and sometimes acids. Due to the multiple attachments found in these compounds, vegetable sources of anthocyanins tend to be more stable, because they are more complex structures.

Grapes, associated with the wine industry, are perfect for pigment production, as the wine-making process generates a great deal of waste. The colorants derived proved to have widespread usage in many products, aided by their stability in processing and storage, and lack of interactions with other compounds. Similarly, producing colorants from other waste materials would make the colorant industry more efficient and sustainable.

INTENSIFYING WITH PIGMENTS

Giusti's research revealed that anthocyanin color might be intensified and stabilized with co-pigments. Colors of anthocyanins may be changed by adding different metals or by using a compound—sometimes a colorless one that shifts or intensifies the resultant color. A compound causing such a shift may mean less colorant is needed to achieve the same intensity. Another class of colorants derived from wine, pyranoanthocyanins, have greater color stability than anthocyanins, Giusti explained, and her laboratory is exploring ways of producing those pigments more efficiently.

Carotenoid colorants, derived from substances such as annatto extract, β-Carotene, paprika/paprika oleoresin and saffron, impart colors from yellow to orange to intense red. Many carotenoids are "nature-identical," derived from natural compounds that mimic the actual substance found in nature. Carotenoids are available in various forms, from a liquid suspension in vegetable oil to beadlet-water dispersible.

Betalains are colorants derived from beets, ranging from yellow to the more typical purplish- red. Betalains are water-soluble and work well close to neutral pH but are sensitive to light, heat and oxygen.

Other commonly used colorants include caramel, which gives a range of brown colors; turmeric, providing yellow and orange hues; and cochineal, an insect source yielding the colorant carmine, which is orange to brick-red. It is mainly used in cosmetics, because consumers oppose the use of insects in food sources.

Both colorant suppliers and those who formulate with colorants attended the Clean Label Conference. Suppliers should work with users to customize and modify colors for each application. Customers will benefit from working closely with suppliers to obtain the best natural solution for their products. This may result in (reasonably) higher costs, but consumer perception will be better. It also facilitates standardized formulations opening international marketing.

"Natural Colorants: Challenges and Opportunities," M. Mónica Giusti, Ph.D., Professor, Dept. Food Science and Technology, The Ohio State University, Columbus, Ohio, giusti.6@osu.edu. [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/the-state-of-natural-colorants-presentation/.]

Practical Advice on Formulating Plant-Based Alternatives

NEW CONSUMER PRODUCTS SUCH AS PLANT-BASED MEAT ALTERNATIVES can generate mass media attention, accompanied by inflated consumer expectations, said Julia Thompson, Culinologist III, CuliNEX. Tremendous 2020 sales growth for plant-based meat alternatives plateaued in 2021, because consumers' taste and texture expectations were not always met. Next-generation ingredients are starting to hit the market, allowing developers to create plant-based meats that are much closer to the taste and texture of meat.

From the perspective of an experienced bench scientist developing plant-based products, Thompson suggested helpful tips for designing such products in her Global Food Forums 2022 Clean Label Conference presentation titled "Practical Formulation with Plant-Based Technologies."

CONSUMER PERCEPTION OF INGREDIENTS

The building blocks of plant-based meat alternatives include protein, fat, flavor, color and functional ingredients. Consumers' preferences matter, so it is essential to identify acceptable components for clean label consumers. CuliNEX partners with Insights Now, a consumer research group that generates scores for individual ingredients based on consumers' perceptions.

Randomization refers to using technology or functional ingredients to make plant-based products more like meat by introducing different textures, shapes and distribution of fats within the product.

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Food companies with which Thompson works often try to avoid wheat and soy protein. Interestingly, however, research shows that wheat is at the top of the protein ingredients consumers view favorably. Wheat has excellent functional qualities that help replicate the flake and fiber of chicken and the "snap" of sausages.

Consumers highly accept pea protein itself; however, qualifiers in the product name, such as "textured," "fermented," "hydrolyzed," etc., result in much lower consumer acceptance, likely because such terms connote a more processed ingredient.

Many of the most popular new protein ingredients come from foods consumers already eat, such as lentils, rice, peanut, pumpkin and chickpeas. Fava bean (faba) is another up-and-coming plant protein. The ability of many plants to serve as protein sources avoids "monocrop" problems related to environmental sustainability, while also reducing supply chain concerns and making reformulation easier.

NEW TECHNOLOGY AND INGREDIENTS

Thompson highlighted new ingredients and processing techniques used to create the next generation of plant-based products. One recent trend involves the use of high-protein, "whole food" ingredients. Traditional breeding can increase protein in plants—which provides a significant upside: You don't need to extract the protein, thus minimizing waste and energy inputs. Whole food ingredients retain fiber and other food components, better absorbing water and providing a more realistic mouthfeel. Novel protein sources are being explored, including plants that grow fast with fewer inputs, such as algae, duckweed and seaweed.

Real meat has random variations in shape, size and texture, while foods with uniform shapes scream "processed." Using technology or functional ingredients to make plant-based products more like real meat by introducing different textures, shapes and distributions of fat within a product is known as randomization.

Fats play a crucial role in making plant-based products more like real meat. Among oils, coconut oil is still perceived well by consumers. In contrast, palm oil, which has excellent functional qualities, is perceived poorly due to sustainability and fair-trade issues. Cocoa butter does not melt like animal fat but can be mixed with other fats to provide a melting curve like that of coconut or palm oil.

Encapsulated fat (water plus fat encapsulated in a plant-based protein) is a new technology that provides an excellent fat-like texture. Importantly for consumers, it also traps aromas and allows their release during cooking, like real meat. Cultivated fat may also become available soon, but it might raise consumer concerns.

Plant-based meat alternatives are generally bland without added flavors. Not surprisingly, consumers prefer typical natural flavors. Soy leghemoglobin is ranked lowest of all flavors surveyed. Paradoxically, however, the products in which leghemoglobin is used are very popular. Several new options for natural flavoring include cystine, which can participate in the Maillard reaction to provide an umami flavor, and specific mono- and disaccharides, where very low levels can enhance other flavors and potentially reduce salt requirements.

Clean label requirements increasingly limit ingredients to those with nutritional benefits, making products such as methylcellulose unpopular—despite excellent functionality. Potato protein, which creates an irreversible gel when heated but requires another component, such as citrus fiber, to hold a product together until it is cooked, may be a more accepted replacement. Another promising binder is red algae, a liquid that gels when heated (like blood) and provides color and flavor, potentially shortening ingredient lists.

While some new ingredients may be unfamiliar to consumers, Thompson believes there is an opportunity to increase their acceptability, if they are sustainable or environmentally friendly. In addition, the precedent of leghemoglobin demonstrates that consumers can overlook a potentially unpopular ingredient—if the final product is tasty.

"Practical Formulation with Plant-Based Technologies," Julia Thompson, Culinologist III, CuliNEX. [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/practical-advice-on-formulating-plant-based-alternatives-presentation/.]

Communicating Corporate Sustainability Efforts

THOUGHT-PROVOKING COMMENTS ON THE USE OF "SUPER LABELS" to convey sustainability information and metrics that arise from tools, such as environmental life cycle assessment (E-LCA), were the basis of a presentation by Sean B. Cash, Ph.D., Bergstrom Foundation Professor in Global Nutrition at the Friedman School of Nutrition Science and Policy, Tufts University. The presentation, "Facets of Sustainability: How Food Companies Can Measure and Communicate Progress to Consumers," was given at Global Food Forums' 2022 Clean Label Conference.

Cash noted significant gaps in diet sustainability research and policy translation. Most of the attention to these topics focuses primarily on human health and environmental impacts. Equally important issues, such as economic sustainability (e.g., the rising cost of food) and social sustainability (labor and livelihoods), are often overlooked. At Tufts, Cash is an investigator in the LASTING

(Leading A Sustainability Transition in Nutrition Globally) program that attempts to address this. Work from that project informed much of his talk.

Cash explains that many product labels rely on third-party certification to offer sustainability assurances. There are some 455 different ecolabels globally across 25 industries, with food and beverage being the most common products with such designations (see Ecolabel Index at https://www.ecolabelindex.com). Other qualities, such as paleo, kosher, non-GMO, vegan, organic, and nut- and dairy-free, also compete with eco-messaging for consumers' attention.

"There are also many metrics like protein scorecards, GHG emissions, land use and carbon footprints," stated Cash, "but these are often very complex and require highly motivated consumers to learn about the product attributes."

The Ecolabel Index website has tracked some 455 different ecolabels globally in 25 industries.

ENVIRONMENTAL AND SOCIAL LIFE CYCLE ASSESSMENTS

E-LCA is a standard tool that estimates a service or product's impact on the environment across its life cycle. Several product-level databases are available (see https://www.circ4life.eu/slca), with

some focusing on the substantial impacts of animal-based products on GHG emissions.

In helping consumers interpret this data, eco-impact labels can be simple logos (reductionist) or very detailed. "Does having much information on the label reassure the consumer that the company is being transparent," asked Cash, "whereas a label with little information may not? Which will we see more of?"

Social LCA (S-LCA) is also of growing interest as a method to assess a product or service's potential social impacts across its life cycle. It combines some of the modeling approaches of E-LCA with social science methods. The resulting metrics may, for example, take the form of the embedded risk of forced labor use in producing a product.

One of the exciting trends Cash predicts will shape the market for sustainable products is the normalization of plant-based proteins and hybrid protein blends of animal and plant. "What was once deemed as adulteration of meat is now enhancement," he said. "This is a huge shift."

Cash noted that producing hybrid products could be a positive way to lower environmental impact that does not require significant changes in consumption. In fact, it might result in a larger percentage of consumers switching to less animal-based foods.

Pressures on food production will come from international climate goals, such as the 26th UN Climate Change Conference of the Parties (COP26), with plans up to 2026. "I predict that, as we progress on energy production worldwide, there will be more focus on food manufacturers communicating in some way on labels showing what they are doing differently to address these challenges," stated Cash.

Stock exchanges are proposing rules to enhance and standardize climate-related scores for investors. For example, the U.S. Securities and Exchange Commission recently released requirements for reporting, as investors care about these issues to safeguard their investments.

ONLINE FOOD LABELS

The nature of the label is changing with the increasing importance of online sales. Cash and colleagues have reported that the rapid growth in web-based grocery food purchasing has outpaced federal regulatory requirements on food product labels (Pomeranz, J, et al. *Public Health Nutr.* 2022/https://bit.ly/3bUbDXT).

This work also included scanning everyday products across nine large online grocery stores. The study found that required information (e.g., Nutrition Facts Panels, ingredient lists, common food allergens and percent juice in fruit drinks) was present for an average of only 36.5% across products and information categories, ranging from 11.4 % for potential allergens to 54.2 % for ingredients lists. In contrast, voluntary nutrition-related claims were often more prominently displayed (63.5 % across retailers and products).

"Online allows new methods to inform consumers on the description page of products that you wouldn't necessarily see at retail," observed Cash. For example, he pointed to an organic hot dog sold by Amazon. The web page's text does not include the Nutrition Facts Panel required by law to appear (and is present) on the physical packaging. He also showed Amazon's "Climate Pledge Friendly" highlighting of labels and products "using sustainability certifications to highlight products that support our [Amazon's] commitment to help preserve the natural world."

In short, the current practice in online retail fails to provide information that would otherwise be required in traditional environments, while simultaneously highlighting additional information that is only sometimes readily available to in-store shoppers.

In conclusion, Cash indicated that although consumers are showing increased awareness of environmental sustainability when they make food choices, production and policy necessities will drive sustainability labeling as much as consumer interest. About competing messages on food products, Cash stressed that "labeling is outgrowing the label."

"Facets of Sustainability: How Food Companies Can Measure and Communicate Progress to Consumers," Sean B. Cash, Ph.D., Bergstrom Foundation Professor in Global Nutrition, Friedman School of Nutrition Science and Policy, Tufts University

Clean Label Sodium Reduction

WHEN THE QUEST FOR HEALTH COMBINES WITH A PURSUIT OF CLEAN LABELS, the resulting formulation challenge means both emerging and underutilized traditional solutions should be considered. Alex Woo, Ph.D., CEO, of W2O Food Innovation, set out to explore clean label sodium reduction at the 2022 Clean Label Conference. Woo provided updates on the rapidly changing field of taste perception and offered innovative approaches to reducing salt in his presentation titled "Sodium Reduction: Using Clean Label Salty, Umami and Kokumi Taste Modulation."

"Flavor," Woo explained, "is our reaction to the food in front of us." It involves all five senses:

1. Taste, of which there are five, including both salty and umami
2. Smell (aroma)
3. Somatosensation (touch), i.e., temperature, pain and spiciness
4. Vision
5. Sound

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The interactive effect of salty and umami tastes is based on a neuroscience concept called prior association. One study showed that the acceptance of a low-sodium burger increased with the mere mention of a mushroom extract.

Neuroscience has made significant advances in understanding how humans perceive taste. For example, "Some 40 taste receptors have been found in the mouth in the past 20 years," said Woo. Bitterness receptors account for 25 of them. In humans, there also could be fat, calcium and water receptors.

A "starchy" receptor was proposed in 2016. Sweetness, umami and saltiness each have one type of receptor. However, the story is more complex than receptors. A secondary pathway for sweetness perception and another pathway for saltiness that responds to high levels of NaCl and to any level of KCl have been discovered.

There are four strategies to reduce sodium, noted Woo. The first is salt substitution with substances less salty than sodium chloride (e.g., potassium chloride [KCl] to replace table salt [NaC]). The second is the increased surface area of NaCl structures, such as the formation of microspheres. The use of umami-tasting ingredients is the third strategy. Fourth, neuroscience (e.g., expectancy constancy) can be utilized.

Woo spent much time discussing how to use umami taste for saltiness modulation. He suggested it is the most important, easiest and most under-utilized method in sodium reduction. There has been much research in this area in the last three to five years.

HOW TO INCREASE UMAMI DIRECTLY AND SALTINESS INDIRECTLY

Adding umami ingredients increases saltiness disproportionately more than expected from the minimal amount of sodium that might be added. The interactive effect of salty and umami tastes is based on a neuroscience concept called prior association. Over time, the mind learns that an umami taste will also be present when saltiness is tasted in food, such as prosciutto. Eventually, the umami taste triggers an associated increase in saltiness. "There are reports that adding mushroom extract, or even the mere mention of a mushroom extract, increased the acceptance of a low-sodium burger," said Woo.

The use of monosodium glutamate (MSG) is a traditional tactic to increase umami. MSG is made by fermenting crops like corn, sugar cane or cassava. MSG has one third that of the sodium of NaCl by weight (i.e., 12% vs. 40%). A blend of 33% MSG and 66% NaCl (by weight) will equal a 25% reduction in sodium but not saltiness.

Many clean label alternatives to pure MSG can be found in nature. They include yeast extracts, hydrolyzed vegetable proteins, soy sauce, fish sauce, and chicken and beef broth. All are naturally high in MSG (or, when in solution, co-exist with the free amino acid glutamic acid) and nucleotides.

Some alternatives labeled "vegetable extracts" have naturally high glutamate (MSG) levels and nucleotides for enhanced umami. Mushrooms are perhaps the most universal flavor with the least amount of off-flavor, advised Woo. High umami extracts, like seaweed and sake lees (aka *sake kasu*), work well with congruent Asian flavors. However, due to their inherent flavors, they can only be used in low dosages or foods with flavors that go together well.

Specific food components also significantly enhance the umami taste. For example, savory dishes with tomato (which contains about 0.3% MSG), corn (contains about 0.6% MSG), Cheddar cheese (about 6% MSG) or Parmesan (8% MSG) are often found to be deliciously savory.

ENHANCING THE UMAMI TASTE

In his presentation, Woo talked about boosting, rather than adding, umami tastes in food through Positive Allosteric Modulator (PAM) molecules. MSG is "trapped" by the T1R1 taste receptor, a concept similar to how the Venus Fly Trap (VFT) plant traps flies.

MSG is bound inside the T1R1 VFT receptor, while PAM molecules bind near the outside of T1R1 VFT receptors. This results in a more tightly bound MSG, which is four to eight times more potent.

Nucleotides IMP+GMP, traditionally called MSG potentiators, have recently proven to be PAM. They bind next to or at the allosteric site where MSG is bound, stabilizing the closed VFT conformation. This increases how tightly MSG is bound and makes it more potent. Both can be argued to be a "cleaner" label than adding pure salt and pure MSG noted Woo.

Much research is taking place in the area of umami peptides, which may be PAMs. Some have been isolated from fermented Asian foods; some are Maillard-reacted peptides. They have yet

to be commercialized. They could be labeled as natural flavor, if made by precision fermentation in the future.

"Sodium Reduction Using Clean Label Salty, Umami and Kokumi Taste Modulation," Alex Woo, Ph.D., CEO and Founder, W2O Food Innovation. [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/clean-label-sodium-reduction-presentation/.]

The Potential of Protein Sweeteners

SEVERAL PROTEIN-BASED, HIGH-POTENCY SWEETENERS (HPS) are being explored for possible commercialization. "The requirements for any new sweetener include regulatory approval, good taste, practical utility and acceptable cost," said John C. Fry, Ph.D., Director, Connect Consulting. Fry explored these factors in his Global Food Forums 2022 Clean label Conference presentation, "Beyond Stevia: Are Protein Sweeteners the Next Big Thing?"

Regulatory approval is the absolute requirement for commercial success. Paradoxically, the toxicological testing that is the foundation of such approval is seldom the first action in a program of sweetener development. This is because such tests are costly and only likely to be applied to substances that have already shown some practical promise as potential HPS.

Consumers generally prefer natural products, as it is widely assumed that these are inherently safer than synthetic additives. However, this is not always true. Fry quoted the example of monatin, a natural amino acid derived from the root of a shrub that grows in Africa. It is a high-potency sweetener with an excellent taste and a history of human use—attributes that recommend it for commercial development. Initial toxicology studies were promising, but further research revealed that, in high doses, monatin affects the heart rate of healthy human volunteers. Commercial development of monatin was abandoned as a result.

In the case of proteins, it is assumed they will be digested into amino acids and metabolized normally. However, this cannot merely be taken for granted and needs to be verified for possible new sweeteners. Secondly, unlike other categories of ingredients,

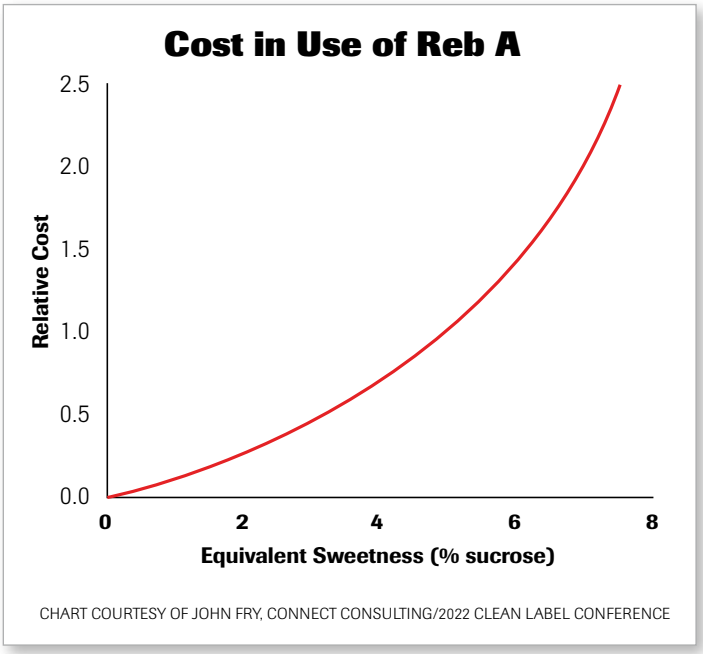

CHART COURTESY OF JOHN FRY, CONNECT CONSULTING/2022 CLEAN LABEL CONFERENCE

Sweeteners must have an acceptable cost, which is a function of potency. Potency depends on the concentration at which it is measured. As an HPS's concentration increases, its potency declines.

proteins are more likely to be allergenic. This adds another safety testing hurdle. Finally, as a class, proteins include some famously toxic materials, such as snake venom, and proposed novel protein additives must also be screened for their toxic potential.

However, taste is generally the first thing to consider in practical terms. For a sweetener, good taste has two key elements. Firstly, we look for a clean sweetness with no unwanted side tastes. The latter include bitter, metallic and licorice tastes that bedevil some sweeteners. Secondly, the sweetness should be delivered on a timescale similar to sucrose. Ideally, the sweet taste should appear (onset) and decline (linger), similar to sucrose. Currently, no HPS exactly matches the dynamics of sucrose, and both slower onset and longer linger are common issues. Of these, delayed onset is, anecdotally, the greater negative for consumers.

PRACTICAL CONSIDERATIONS BEYOND SWEETNESS

Practical utility involves solubility and stability. Solubility is not generally a problem, as high-potency sweeteners are typically used at concentrations of only a few parts to a few hundred parts per million. Nevertheless, it can be challenging to make liquid concentrates if these are required. For example, some steviol glycosides are limited in use because of poor solubility.

A candidate sweetener must also be stable through its isolation, storage and transport stages as a raw material. Subsequently, it

must survive common processing steps—especially pasteurization and, possibly, baking or canning. Finally, it must be adequately stable in the finished consumer product.

Potential sweeteners must also have an acceptable cost, essentially a function of potency. Potency is the effectiveness of a sweetener on a weight basis compared to sucrose. All HPS have a curved concentration-response relationship, where sweet intensity tends to plateau as concentration increases. In other words, potency depends on the concentration at which it is measured. As the concentration increases, the potency declines. (See chart "Cost in Use of Reb A.") This, in turn, means that the cost-in-use rises with rising concentration.

Another common effect of increasing concentration is that unwanted side tastes are more likely to be perceived. This and the impact on cost are powerful reasons not to use HPS near their concentration-response plateau.

Potency values range from about 30 (for cyclamate, the weakest of the global commercial HPS) to thousands for sweeteners such as neotame and advantame. A good target for a new sweetener would be several hundred or above.

There is a surprisingly short list of sweetener candidate proteins. Most are from plant sources; one (lysozyme) is animal, but there is growing interest in customized synthetic proteins. Many protein sweeteners of natural origin have defects that make them unsuitable for commercialization. After eliminating the candidates with significant flaws, four remain and have received some attention: thaumatin, miraculin, brazzein and designer proteins.

Thaumatin is derived from the katemfe fruit that grows wild in Western Africa. There are five isoforms, but the sweetener is mainly in forms I and II. There are widely differing potency estimates, but most agree that it is several thousand. Thaumatin has a prolonged onset and a long linger. At 5% sucrose equivalent, some individuals can still taste thaumatin 30 minutes later. However, thaumatin is commercially successful and widely used as a flavor modifier rather than a sweetener.

There has been much recent attention paid to miraculin. This protein is present in the miracle fruit that grows wild in Western Africa but can be grown commercially in many parts of the world. Miraculin is only sweet when exposed to acids. In neutral saliva, miraculin is tasteless and blocks the sweetness of other sweeteners. When exposed to acid, miraculin's structure changes and triggers a very sweet taste. Miraculin remains bound to the sweetness receptor for 20 minutes to an hour. The EU has approved miraculin as a

novel food, but a recent USA GRAS notification has been withdrawn because of insufficient safety data. Owing to the need for acid; the unpredictability of the sweet response; and the long-lasting effects, the practicality of miraculin as a sweetener is dubious.

Brazzein is a potently sweet protein obtained from the pulp of the Oubli fruit (*Pentadiplandra brazzeana Baillon*) that also grows wild in Western Africa. Its potency is around 1800 at 5% sucrose equivalent. It has a high-quality sweetness, and this is one of the rare HPS that can reach 10% sucrose equivalent on its own, which is a level typically found in carbonated beverages or fruit juice. Its dynamics are still an issue, as brazzein takes four to five seconds to reach peak sweetness. It needs to be blended with another sweetener that has a faster onset to achieve more sugar-like dynamics. Several groups are working on the commercialization of brazzein.

Designer proteins start with a protein from nature, and the structure is changed with modern computational protein design. The subsequent molecule can be produced by fermentation. The technique can improve properties, such as greater stability or higher potency. The result is also currently called a "mutant" protein, as it does not exist in nature. Fry suggests that the industry should develop a more consumer-friendly name. Although potentially attractive, these novel proteins represent regulatory approval and marketing challenges. Ultimately, they will probably be considered artificial sweeteners.

Of these four HPS, thaumatin is already a commercial success—but more as a flavor modifier. Miraculin would seem to have little prospect of being more than a curiosity, while brazzein and designer proteins are under active development.

"Beyond Stevia: Are Protein Sweeteners the Next Big Thing?" John C. Fry, Ph.D., CChem, FRSC, FIFST, Director, Connect Consulting. [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/the-potential-of-protein-sweeteners-presentation/.]

Labeling Fiber & Sugar: Maximizing Advantages, Minimizing Risk

FDA'S 2016 DIETARY FIBER REGULATIONS went into effect in July 2020. The Daily Value of fiber increased to 28g per day. However, "In the U.S., no analytical method truly measures fiber, but rather measures non-digestible carbohydrate (NDC)," explained David Plank, Senior Research Fellow, Univ. of Minnesota. Plank delved into the topic during his presentation titled "Labeling Fiber & Sugar: Maximizing Clean Label Advantages, Minimizing Class Action and Recall Risk" at Global Food Forums' 2022 Clean Label Conference.

Examples of Intrinsic and Intact Dietary Fiber

Intrinsic and Intact	Not Intrinsic and Intact
• Vegetables	• Sugar cane fiber
• Whole grains	• Apple fiber
• Fruits	• Bleached oat hulls (oat fiber)
• Nuts	• Isolated fibers
• Pulses	
• Cereal bran	
• Flaked cereal	
• Flours	

SOURCE: DAVID PLANK, WRSS FOOD & NUTRITION INSIGHTS/2022 CLEAN LABEL CONFERENCE

Intrinsic and intact fibers are self-determined by the food manufacturer, while FDA determines isolated or synthetic fibers based on a citizen petition.

NON-DIGESTIBLE CARBOHYDRATES AS DIETARY FIBER

Insoluble NDC contains zero calories per gram. Soluble NDC contains about two calories per gram, and digestible carbohydrates four calories. The new definition of dietary fiber corresponds to the Codex definition, said Plank. Dietary fibers are non-digestible, soluble and insoluble carbohydrates with three or more monomeric units and lignins, either intrinsic and intact or isolated or synthetic. Intrinsic and intact fibers are self-determined by the food manufacturer, while FDA determines isolated or synthetic fibers based on a citizen petition. (See chart "Examples of Intrinsic and Intact Dietary Fiber.")

The requirements for Intrinsic and Intact Dietary Fiber are: 1) the fiber originates and is included wholly within a food and that no relevant components have been removed or destroyed; and 2) that the U.S. population must traditionally consume the dietary fiber.

Examples of intrinsic and intact fibers include those from vegetables, whole grains, fruits, nuts and cereal bran. The category does not include sugar cane fiber, apple fiber and bleached oat hulls, because significant dietary components have been removed.

Isolated or synthetic NDC must demonstrate at least one physiological benefit to health, such as lower blood pressure, reduced glycemic response, weight loss or laxation, before they can be included as dietary fiber. Certain fibers already had health claims, such as beta-glucan, psyllium husk, cellulose and guar gum, were approved with the rule. Examples of fibers approved through the citizen petition include mixed plant cell wall fibers, alginate, inulin and high-amylose starch. Polydextrose is unique, because it has a caloric value of 1kcal/gram. Recent additions include glucomannan and acacia gum.

"Your product must be analyzed by an official method such as AOAC 2011.25 or AOAC 2017.16 for soluble and insoluble NDC. Using a database is not acceptable," said Plank. Through record-keeping, a company must subtract the amount of recorded FDA-approved dietary fiber from the total amount of NDC analyzed. There are various approved AOAC methods, but the newer, more physiological methods will provide safer data from a labeling viewpoint.

DELINEATING SWEETENERS AND SWEET FIBER INGREDIENTS

When measuring total dietary fiber in resistant starches, the older AOAC 991.43 (boiling water bath) method delivers significantly higher results than the newer AOAC 2009.01, a more physiological method. The latest method, AOAC 2017.16, is the most physiological; most closely simulates consumer digestion; and best correlates to human glycemic response. Plank reminded the audience that dietary fiber could be lost during food processing by heat, moisture, acid, shear, Maillard reactions and enzymes.

Recordkeeping is essential, and records must be maintained for a minimum of two years. To reconcile your data, you must first analyze for NDC and compare results to records for added dietary fiber. You can label all analyzed NDC as dietary fiber if they are equal. If not, you should only label analyzed NDC as dietary fiber.

Total grams of carbohydrates is a calculation of 100 minus the grams of protein, fat, moisture and ash. When calculating calories, use the Atwater Factors and, per the new regulations, use two times soluble NDC and four times insoluble NDC.

From a clean label perspective, the ultimate sugar label declaration is 0g of added sugar. Many manufacturers use a combination of sugar alcohols and high-intensity sweeteners. Below are some special situations.

• FDA has assigned alternative calories to all sugar alcohols. To make a sugar claim, you must list the total grams of sugar alcohol. Note that sugar alcohols may interfere with labeling sugars, and gas chromatography is the safest analytical method.

• Allulose has 0.4 calories per gram and is unique, in that it is not included in total or added sugars, but must be included in total carbohydrates.

• Grain syrup sweeteners must list sugars as added sugars, and enzymes must be labeled unless inactivated.

• When using fruit or vegetable extracts, if the sugar added exceeds the content of the whole fruit, as in fruit concentrates and powders, the sugar must be labeled as added sugars.

Due diligence to detail in labeling fiber and sugar will minimize the risk of recall, FDA enforcement action or class action lawsuit.

"Labeling Fiber & Sugar: Maximizing Clean Label Advantages, Minimizing Class Action and Recall Risk," David Plank, Managing Principal, WRSS Food & Nutrition Insights/Senior Research Fellow, Department of Food Science and Nutrition, University of Minnesota [For more information, see Plank's presentation at https://globalfoodforums.com/wp-content/uploads/2022/05/Labeling-Fiber-and-Sugar-D.Plank-updated.pdf .]

Clean Ways to Deal with Challenging Flavors

FLAVOR IS THE PRIMARY DRIVER of consumer acceptance and repeated purchases of foods. Or, as Keith Cadwallader, Ph.D., Dept. of Food Science & Human Nutrition, University of Illinois at Urbana-Champaign, succinctly said: "Flavor rules."

Surprisingly, given such importance, only limited academic research has been focused on flavors. More often, food companies are the leading innovators in this area. Cadwallader went on to delve into the issue and options of flavorings in his Global Food Forums 2022 Clean Label Conference presentation, "Considerations in Natural Flavoring Use in a Clean Label World."

Flavor is a complicated, multisensory experience encompassing taste, odor, texture, appearance, temperature, trigeminal profiles and sound: potato chips must "crunch." Odor, however, is the predominant force in flavor, responsible for about 80-95% of the perception of flavor. Most commercial flavorings, therefore, are primarily composed of aroma chemicals.

DEFINING CLEAN LABELING AND NATURAL FLAVORS

While emphasizing that many different definitions exist, Cadwallader outlined what "clean labeling" means to him:

• A clear, precise label with a shortened ingredient list

• Packaging, labels and declared ingredients that convey quality, wholesomeness and healthfulness

U.S. AND EU DEFINE "NATURAL" DIFFERENTLY

• U.S.—An essential oil, oleoresin, essence or extractive, protein hydrolysate, distillate, or any product of roasting, heating or enzymolysis… (source material must be natural). [21DFR101.22]

• EU—Source material must be vegetable, animal or microbiological. Must be produced by traditional food preparation process. Natural flavoring substances correspond to substances identified in nature.

Source: Keith Cadwallader, Ph.D., University of Illinois at Urbana-Champaign/2022 Clean Label Conference

• Labeling may indicate what is NOT in the product ("free from GMOs," "low in sodium," etc.)

• Minimally processed

Natural flavors are essential for a clean label product. The U.S. and the EU definitions for natural flavors differ but share considerable overlap. (See sidebar "U.S. and EU Define 'Natural' Differently.")

Plant-sourced flavors, such as extracts, essences and essential oils, are considered clean label, as are flavors derived via fermentation. Even if defined and regulated as natural, consumers may not accept it as a clean label ingredient. For example, liquid smoke is made via a natural process that consumers might view as a chemical processing step.

Other flavors considered natural from a regulatory perspective that may not be viewed as clean label by consumers include GMO technology-derived flavors or flavors obtained from nuts (because of potential allergen concerns). Common natural flavors, such as hydrolyzed vegetable protein (HVP) or autolyzed yeast extract (AYE), have technical names, which may make them less acceptable for some.

HVP, AYE or monosodium glutamate (MSG, a key ingredient in HVP and AYE) are added to foods for flavor and taste enhancement but may not be considered clean label ingredients. Clean label alternatives to these ingredients include ripe tomatoes and other vegetables, cheese extracts, soy sauce, fish sauce and mushrooms. However, it is essential to consider what other flavors these ingredients may bring to a formulation.

Consumer acceptance may also be improved by using an alternative declaration statement. Cadwallader suggested focusing on specific food names rather than "molecule" names when possible. For example, "hydrolyzed wheat protein" may be more acceptable than "hydrolyzed vegetable protein."

Despite its long history of safe use and regulatory status as a natural flavor, liquid smoke might not be accepted as a clean label ingredient by some. The same flavor might be obtained in food while maintaining a clean label by using wholesome ingredients, such as "smoked cheese" or "natural hardwood smoked sugar," to impart smoked flavor instead of liquid smoke. However, it should be noted that smoked ingredients may not be safer than liquid smokes that undergo stringent purification steps to ensure their safety.

Vanilla is the world's most popular flavor, but its limited supply makes natural vanilla extract very expensive. Vanillin is a crucial compound within natural vanilla extract that replicates much of its flavor, but it is cheaper and can be produced more sustainably.

Cadwallader discussed the pros and cons of various sources of vanillin. Natural vanillin can be obtained from vanilla bean pods, but it is still an expensive product, costing roughly $1,500-4,000/kg. Natural vanillin can also be obtained in good yield from other natural substances, such as ferulic acid (a component of rice bran) or eugenol (derived from cloves) via bioconversion/fermentation. This vanillin is considerably cheaper (>$100/kg) and can be labeled "natural" but may require FDA regulatory approval for the process.

Vanillin also can be chemically synthesized from wood products such as lignin. While this vanillin is much cheaper ($10-15/kg), it must be labeled as "artificial" or "synthetic" vanilla flavoring in the U.S. Ethyl vanillin (which is a compound not found in nature) can also be used and is very inexpensive but, again, must be labeled as artificial vanilla flavoring in the U.S.

Clean label is a dynamic concept driven by consumers. It is as much about what is in the product as what's not in the product. To help meet the demands of the clean label-conscious consumer, manufacturers have stepped up efforts to produce natural biotech flavors using non-GMO approaches. Changes in clean label flavor uses are likely due to continuously evolving consumer demands, regulatory requirements and industry innovation.

"Considerations in Natural Flavoring Use in a Clean Label World," Keith Cadwallader, Ph.D., Dept. of Food Science & Human Nutrition, University of Illinois at Urbana-Champaign

Developing Alternative Milk Products

AS A PARTICIPANT IN THE APPLICATIONS PANEL during the 2022 Clean Label Conference, Lindsay Wisener, MSc, Owner & Lead Product Developer, WiseBev, delved into the aspects of developing alternative milk products. Her her presentation was titled "Technical Challenges of Alternative Dairy Beverages + A Comment on Botanicals."

When formulating alternative milks, raw material selection is critical to product functionality, marketing and branding. For instance, what is the goal regarding claims? Will added sugar, which requires labeling, be a problem?

Chemical composition considerations include determining desired protein, insoluble fiber, sugar and fat content—plus the type of starch (i.e., gelling characteristics, reaction to heat, etc.). Several protein sources may be combined to boost protein, as in the Silk Protein product (see chart "Nutrition in Marketplace Alternative Milks"), which contains almond, cashew and pea to boost the protein to its 10g target, Wisener noted.

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Nutrition in Marketplace Alternative Milks

Product	Calories	Protein (grams per serving)	Fat (grams per serving)	Total Carbohydrates (grams per serving)	Sugars (grams per serving)
Cow's milk whole	150	8	8	12	12
Silk Almond Milk extra creamy	90	1	8	7	6
Silk Soy Milk original	110	8	4.5	9	6
Silk Protein	130	10	8	3	2
Ripple original (pea protein)	80	8	4.5	<1	0
Oatly original	120	3	5	16	7

SOURCE: LINDSAY WISENER, WISEBEV/2022 CLEAN LABEL CONFERENCE

When developing milk alternatives, the level of solids compared to dairy milk and the usage rates of raw materials should be considered. Since proteins are generally the most reactive ingredients, formulation factors, such as ingredient additions, processing, texture and flavor, are also important.

When developing an oat milk-based product, starch inherent in oats will gel unless it is hydrolyzed. When hydrolyzed, the resulting ingredient is labeled as "partially hydrolyzed whole oat flour." This causes somewhat of a paradox. First, is this considered a clean label? Secondly, the hydrolysis process results in added sugars.

OTHER CONSIDERATIONS

Physical characteristics, such as particle size, must also be considered. For example, a nut butter used in a bar isn't the correct particle size for a beverage. "Some particles are so big…they aren't going to result in good products, and they're not going to process well," Wisener explained.

When batching alternative milks, dispersion and hydration are critical. Increasing the water temperature slightly helps with hydration, Wisener noted. Nearly all alternative milk products are produced using extended shelflife (ESL)or aseptic processing, so the pH should be kept near neutral.

Buffering agents are used in alternative milks to maintain a neutral pH and keep it from drifting toward the protein's isoelectric point. Phosphates are commonly used as buffers, although Wisener has had some requests not to use these ingredients in clean labeled products. "Really, …it's about the tradeoffs in functionality between what your product is and isn't going to do," she said.

Calcium carbonate is also used as a buffer. While it can be very interactive with protein, less soluble forms are used to avoid these interactions. It also aids in whitening to produce a more milk-like appearance.

Regarding texture, gums and fat help mimic the creamy texture of dairy milk. Gellan gum and locust bean gum suspend small, insoluble particles. Coconut milk is used in products for its creaminess. It can be challenging to emulsify, so obtaining the correct mix may take some work, Wisener noted.

Flavors can be highly reactive with proteins, requiring flavor maskers, blockers or enhancers to achieve the desired flavor throughout the shelflife. Wisener has noticed many requests to include flavor extracts instead of natural flavors. "I've seen some brands where that, to them, speaks to clean," she added.

What's next for the alternative milk market? Blends are on the horizon. Also, alternative milks are made using potato, chickpea, hemp and seed proteins. Upcycling, or using byproducts instead of creating waste, is becoming more common. Some producers can use their own byproducts, such as the starch leftover after producing protein. The resulting end-products are not only dairy-free but good for the planet.

Many factors must be considered when developing clean alternative milk beverages. It often comes down to the tradeoffs in terms of functionality vs. brand messaging, Wisener claimed—adding yet another challenge to the mix.

"Technical Challenges of Alternative Dairy Beverages," Lindsay Wisener, MSc, Owner & Lead Product Developer, WiseBev [To access

the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/developing-alternative-milk-products-presentation/.]

Meeting Food Safety Standards in Clean Label Dressings

MALCOND VALLADARES, PH.D., Food Scientist, The National Food Lab (NFL), systematically covered the process necessary to meet food safety standards for one popular application at Global Food Forums' 2022 Clean Label Conference. His presentation, titled "Considerations for Selecting and Evaluating Clean Label Antimicrobial Ingredients for Dressings," reviewed four key steps that must be taken when formulating clean label, non-thermally processed salad dressings (and other acidified foods).

FDA's Title 21CFR117 provides regulations for hazard analysis, risk-based preventative controls and good manufacturing practices (GMPs). Begin by defining the regulatory space for your product, advised Valladares. He then focused on salad dressings classified as acidified foods made from high- and low-acid ingredients. Acidified foods are shelf-stable, have a pH of less than 4.6 and a water activity (Aw) over 0.85.

Valladares stressed the importance of allowing particulates to reach equilibrium with the rest of the formula before testing to ensure a pH is less than 4.6. Equilibrium can take up to 24 hours to occur.

Possible sources of microbial risk include ingredients, the production environment, processing and storage, and recontamination.

Pathogens, such as *E. coli* 0157:H7, *Listeria Monocytogenes* and *Salmonella enterica*, and spoilage microorganisms, like lactic acid bacteria, yeast and mold, are of concern. "This is especially true when the manufacturing process does not include a kill step process or treatment to mitigate the microbial risks associated with these products," Valladares emphasized. "There's a high chance that mold can grow over time, and mold can shift the pH, allowing pathogen growth, as well," he added.

"A clean label system must deliver a validated pathogen kill step of 5-log reduction for pathogens of concern," Valladares said. This system depends on a specific combination of formula and process, as does inhibiting spoilage microorganisms for improved shelflife. The goal is to assess the robustness of the formula to environmental contamination during processing and secondary growth after opening and storage.

SCREENING FORMULATION OPTIONS

Standardized formulation parameters for salad dressings can be found in 21CFR169. The International Commission on Microbiological Specifications for Foods (ICMSF) established specific ranges of certain ingredients. Usage of acetic acid at

Clean Label Antimicrobials

Ingredient Type	Active Ingredient	Use Level	Antimicrobial Spectrum	Sensory Impact	Labeling
Concentrated buffered acetic acid	Acetic acid	0.5-2.5%	Lactic acid bacteria, yeast and mold	Additional acid/ sour notes	Vinegar and natural flavoring
Lactic acid	Lactic acid		Gram negative	Additional acid/sour/ fermented notes/ dairy notes	Lactic acid
Bacteriocins (Natamycin)	Natamycin	5-50ppm	Yeast and mold	Very little flavor impact	Natamycin, natural antimicrobial, food protectant
Bacteriocin (Nisin)	Nisin	25-500mg/kg	Gram positive, gram negative, lactic acid bacteria	Cooked flavor note	Fermented dairy
Fermented dextrose	Cultured dextrose	0.2-1.5%	Yeast and mold	Additional acid/sour/ fermented notes	Cultured/fermented dextrose Fermentates
Rosemary extract (antimicrobial and antioxidant)	Extract of rosemary	200-1000ppm	Gram positive	Herbal extracts can be overpowering	Natural extractives of rosemary
Chitin (aminopolysaccharide biopolymer)	Chitosan	3.6ml/lb-54ml/lb	Gram positive, gram negatives, fungi and viruses	May enhance umami notes	Mushroom extract

SOURCE: MALCOND VALLADARES, PH.D., FOOD SCIENTIST, THE NATIONAL FOOD LAB/2022 CLEAN LABEL CONFERENCE

One of these ingredients may not be the solution or the silver bullet for controlling all the different microbial risks of your product," stressed Malcond Valladares, Ph.D., Food Scientist, The National Food Lab. Thus, combinations of different components may be required.

0.5-1.5% will keep the pH well below the 4.6 threshold, advised Valladares. The ICMSF also recommended salt concentrations of 1-4% and sugar concentrations of 1-30%. Even so, these parameters result in an Aw of 0.95, which is above the threshold for the growth of pathogens and microbes, thereby requiring preservative ingredients. (See chart titled "Clean Label Antimicrobials," which provides a list of clean label ingredients used to control microbial risk.)

Various tests are required to ensure the viability and stability of the product. Flavor stability should be checked throughout the shelflife, as should the visual quality of your product.

Once a formulation is developed, the 5-log kill step for pathogens must be documented. The processing authority may need to review the formula and process and determine if FDA filing is required. The pathogenic kill step is validated via a microbial challenge study in triplicate per sampling time. This study determines the time needed to achieve a 5-log reduction under storage conditions. Data generated from the microbial challenge study must be robust enough to support a food safety plan.

Finally, shelflife studies assess the product's robustness during storage and test for recontamination over time. Valladares recommends running a spoilage challenge study that is 1.5 times the desired shelflife target under relevant storage conditions.

He concluded by emphasizing that the spoilage challenge study cannot predict shelflife past the time indicated in the microbial challenge study.

"Considerations for Selecting and Evaluating Clean-Label Antimicrobial Ingredients for Dressings," Malcond Valladares, Ph.D., Food Scientist, The National Food Lab [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/meeting-food-safety-standards-in-clean-label-dressings-presentation/.]

Clean Labels & Sustainable Systems: Food Scientists' Role

A FASCINATING APPROACH TO FOOD SCIENTISTS' role in advancing clean label products was presented as part of the Applications Panel at Global Food Forums' 2022 Clean Label Conference by Jonathan Gordon, Ph.D., President, Glasgow Growth Partners. In his presentation, "A Food Scientist's Role in Advancing Clean Labels and Sustainable Food Systems," Gordon began with a brief history of the chemical movement that developed around the beginning of World War II but focused more on how clean labels, healthy foods and beverages are created and manufactured.

Since many chemical-based ingredients have only been available for a short time, the adverse effects of some of these chemicals are only recently being realized. Yet, some of these chemical-based ingredients are perfectly harmless.

So, where do food scientists begin when developing clean label products? Gordon emphasized the following four points:

- Start at the end.
- Always maintain an overview perspective.
- Don't solve problems that don't exist in practice.
- Try to find a "physical" solution before you look for an ingredient solution.

MAINTAIN AN OVERVIEW PERSPECTIVE

As Gordon delved into details regarding these practical steps, he provided sage advice from his experience in product development. He advocated looking at the equipment and process in a new way. Can the equipment do anything differently? Is there a piece of equipment in another production room that can be added to your production line? Can the piping be arranged differently, or can the equipment order be rearranged? Can you persuade the plant personnel to do what you want?

Maintain an overview perspective. For example, equipment or line location changes might provide a physical solution to an issue when reformulating a standard product to a clean label.

As a scientist, it is sometimes challenging to have an overview mentality. Higher education will propel one toward taking a narrowly defined focus "until we become complete experts in something almost nonexistent," Gordon said. It's important to see outside the box, beyond your focus of expertise and look down from above. "Allow yourself to see beyond what you're doing," he added.

Do your homework, Gordon advised. Become as much an expert in the subject, and let your mind wander. Don't solve problems that aren't there. Avoid using compound ingredients if you can do it more effectively from scratch.

If ingredients are a problem, try not to use them. Process solutions can sometimes overcome issues. Gordon provided the example of a bar topping high in oil. When the topping is mixed and subjected to high shear, the coconut fat melts and separates from the topping. One solution? The meat industry uses ice chips in their bowl chopper. "Can we throw CO2 chips into our mix and cool it down while mixing it?" asked Gordon. "It's an alternative way to think of things."

Product developers should consider other important factors when formulating a new product. They include physical characteristics and the importance of hydration for optimal performance; the critical nature of temperature; and the order of ingredient addition.

As an example of one of the key points above, Gordon described how temperature could make a difference in processing foods,

particularly proteins. "[During] aseptic processing of proteins, proteins are heated during preheating and aseptic processes. If you can denature the protein in the preheat, they won't crosslink in the aseptic process and gel in the end product."

It isn't always easy for food scientists to work around consumers' attitudes involving clean labels. "We are responsible for the mess," Gordon said. "While trying not to say anything too negative, Twinkies didn't invent themselves. We've got to fix it—since we're the people on the front lines doing the work."

"A Food Scientist's Role in Advancing Clean Labels and Sustainable Food Systems," Jonathan Gordon, Ph.D., President, Glasgow Growth Partners [To access the presentation PDF, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/clean-labels-sustainable-systems-food-scientists-role-presentation/.]

Global Food Forums' staff thanks the attendees, speakers, sponsors and exhibitors at the 2022 Clean Label Conference. Our next in-person event, the 2023 Clean Label Conference, will take place on May 23-24 at the Westin, Itasca, Ill. We look forward to seeing many of you there.

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