Food Science Advice for Formulating Foods & Beverages

How to Flavor Protein-Based Products

Spring 2020

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2020 FLAVORING PROTEINS MAGAZINE

Through the years, attendees at Global Food Forums' conferences have been presented impartial and non-commercial advice from industry experts with lifetime careers in food science. The belief is that product developers more successfully and effectively meet formulation challenges when they understand the chemistry behind ingredient interactions in a product's matrix. In this special issue, Global Food Forums' editorial staff gathered key post-conference summaries of past presentations by recognized authorities in the food flavoring and sensory areas. Information ranges from a 2014 article on foundational applied flavor chemistry to 2020 updates and new information, starting with an overview of current flavoring trends. We hope this must-read publication leads to more successful R&D projects and products for readers and their companies.

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Flavor Trends in 2020 Convey Far More than Just Flavor

By Paula Frank, MSc, MBA, Content Manager, Global Food Forums, Inc.

FLAVORS, LIKE BRANDS, have a story to tell. Is the flavor unique, healthful or indulgent? Is it indicative of its origins, whether locally or globally sourced; is it part of a country or region's cuisine? Does the flavor represent a certain plant cultivar? A 2019 survey* by Innova Market Insights showed that 41% of global consumers want to know the story around a brand, because they want to learn where the ingredients are from; 56% of global consumers say stories around a brand influence their purchase decision.

When recent food and beverage trends are analyzed, they also tell a tale of what consumers truly value. These values include health, sustainability, ethics, transparency, globalization, authenticity, novelty, indulgence, relaxation and clean label. First and foremost, however, taste is valued above all else.

Thus, when flavor trends are compared to overall food and beverage trends, it is apparent that they align with consumers' core principles and expectations.

The broader flavor trends presented here provide ideation input for the wide array of protein-based, formulated foods and beverages under development.

Getting in on the Exclusive

Today, consumers seeking new experiences have multiple opportunities to try foods and beverages developed with unique flavors. As *Food Ingredients First* reports, a 30% growth of new food and beverage launches with floral flavors were reported globally in 2018 vs. 2016. And, a 26% increase of new product launches with "fresh and zesty citrus flavors" occurred globally in 2018 vs. 2017 (*Food Ingredients First*, April 2019, https://bit.ly/3cafNpT).

Regarding floral flavors, menu items made with hibiscus flavor showed a 55% increase from 2015 to 2018, as indicated by Mintel in its "U.S. Flavor & Ingredient Trends 2019" report. Floral flavors not only capture a sense of novelty but align with other botanical and herbal flavors in promoting a feeling of relaxation, while minimizing stress. Although floral and botanical flavors have become popular in those seeking spirit-free beverages; Wallaby® Organic No Sugar Added Aussie Greek Peach Hibiscus yogurt, sold by Whole Foods, provides a food example. The floral trend is also evident as part of Innova Market Insights' top 10 flavor trends, with its special edition flavors that include a celebration of Spring with cherry blossom, rose and lavender as on-trend flavors.

Social media has brought consumers closer to cuisines with which they are less familiar, as have restaurant menus and food trucks. Growth in global ready-meal launches featuring ethnic flavors was highest for Mediterranean (+39%), followed by Latin American (+32%) and East Asian flavors (+16%), from 2014 to 2018, as reported by *Food Ingredients First*.

Today, Middle Eastern, West African, Indian and Japanese flavors are particularly on trend. India's masala flavor, as featured in menu items, increased by 141% from 2015 to 2018, reported Mintel. Masala is a seasoning blend containing cumin, coriander, green & black cardamom, cinnamon, nutmeg, cloves, bay leaves, peppercorns, fennel, mace and dried chilies.

Warm spices, such as those noted above, are appearing not only in ethnic cuisine, but in traditional fare. Blueberry Spiced So Delicious® CoconutMilk Yogurt Alternative Pairings brings blueberry yogurt together with cardamom-ginger almonds.

Hybrid flavors, or those that combine spicy-sweet or sour-spicy and beyond, put a new spin on more traditional flavors

Flavor trends reflect consumers' key values and interests.

—giving consumers the opportunity to try something new without exceeding the boundaries of their own comfort zones.

Salted egg flavor, in terms of new food and beverage launches, has doubled from 2018 to 2019, per Innova Market Insights. This flavor is not only on trend because of its Asian origins; it is often paired with something sweet, for a salty-sweet hybrid.

Tracing Origins

Consumer demand for clean labels and transparency, combined with a curiosity for novelty, authenticity and indulgence, brings to light the significant trend of identifying sources of flavors and ingredients. Storytelling strategies, through use of ingredient provenance and taste and flavors, are among Innova Market Insights top 2020 flavor trends. Ingredient identification may be global, regional or local in nature; it may reveal a plant's cultivar or varietal; or it may even name a type of process.

An example of origin labeling is Bella Lucia™ Gluten Free Pizzelles, which are made with Saigon Cinnamon. Vanillas are often identified as Madagascar, Tahitian, Indonesian or Mexican. Curry Love Organic Medium spicy Sri Lankan Curry Sauce pinpoints a regional type of cuisine. Foods and beverages that specify Wilamette raspberry, Monterey strawberry or Alphonso mango on the label, for example, identify the fruits' cultivar or varietal type.

Way of Life

Health and wellness seemingly run a close second behind taste among consumer values, as evidenced by high protein demand. Plant-based proteins, particularly protein-rich pulses and nuts, can be found in a variety of foods and nutritional supplements.

Among Pollock Communications "Health, Wellness and Nutrition Top 2020 Trends" is a sub-list of top 10 superfoods that include avocado, blueberries, nuts, exotic fruits, ancient grains and fermented foods. The popularity of blueberry is indeed evident among retail products. Examples of such reveal a range of blueberry origins and combinations with other flavors. These products include KeVita Blueberry Basil Master Brew Kombucha®, Yoplait® Mountain Blueberry Yogurt, The Greek Gods® Honey Blueberry Yogurt and Chobani® Less Sugar Wild Blueberry Yogurt.

Fermented foods, such as kombucha, drinking vinegars, kimchi and kefir are known for their health benefits, given the presence of antioxidants, probiotics and other nutrients. Consumers are becoming more accustomed to the sour taste associated with many of these foods and beverages.

When Innova Market Insights published its top trends for 2020, it couldn't have been closer to reality with its "Storytelling: Winning with Words" prediction. Yet, it is not only foods or beverages that tell the tale, but the ingredients within them. So, no matter whether origin, novelty, indulgence, health or some other value factor into consumers' purchasing decisions, it's the flavor that tells the true story.

* Innova Consumer Survey 2019. Average of UK, U.S., Spain, France, Brazil, India, Germany, Mexico and China

"Flavor Trends in 2020 Convey More than Just Flavor," Paula Frank, MSc, MBA, Content Manager, Global Food Forums, Inc.

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Protein Flavoring Problems and New Protein Sources

FROM A FOOD OR BEVERAGE product developer's point of view, does it make more sense to match the flavor to the protein or the protein to the flavor? This is only one of the questions addressed by renowned University of Minnesota flavor expert, Gary Reineccius, Ph.D., during his presentation at a Clean Label Conference that delved into the art and science of flavor. Here, Reineccius offers new additional thoughts to the original presentation, particularly as it relates to new protein sources.

"Flavor" is a holistic response to chemical stimuli contributed by specific combinations of selected and highly reactive aroma chemicals (about 11,300 have been identified in nature). Other contributors include non-volatile tastants (salty, sweet, sour, bitter, umami); and chemesthetic signals (e.g., heat of peppers and cooling of menthol).

These combined chemical stimuli provide a pattern of signals to the brain that are perceived as flavor.

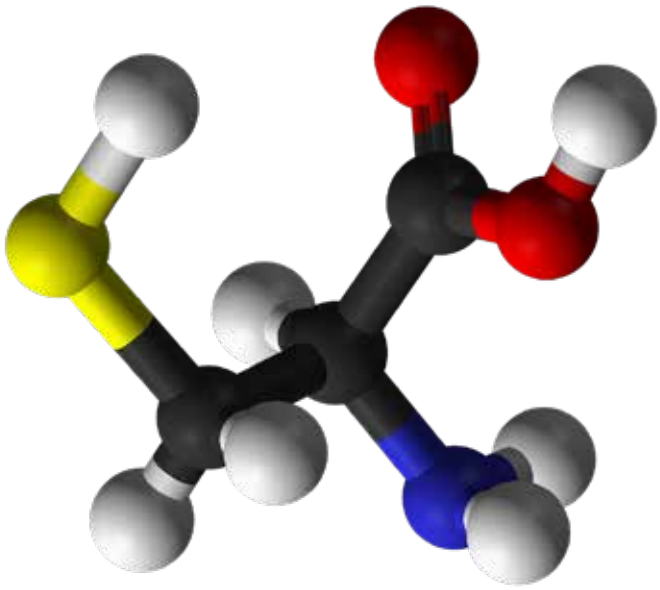
This same constellation of sensory signals must be rigorously managed throughout a food's manufacturing, storage, handling and preparation processes to ensure that, in the end, "the balance of a product's sensory inputs meets our expectations," says Reineccius.

The growing consumer demand for more protein in our diets, along with an interest in sustainability, has put both higher levels of proteins and new/novel proteins (from many sources but most commonly plant sources, e.g. pea) into the marketplace. These new protein sources create challenges in product development, such as flavoring, since these materials very commonly bring off-flavor characteristic of their source.

The flavor industry frequently suggests that these off-flavors can be managed through masking of the off-notes with the use of a flavor composition that reduces the sensory impact of the off-notes. While this approach is commonly tried, it is seldom very successful. Masking an "off-aroma" is a great deal more challenging than masking an off-taste. We need to understand what is responsible for the undesirable notes provided by our unique proteins, so breeding programs can produce lines that have reduced off-notes and/or processing steps that need to be altered to remove these undesirable compounds from the final protein isolate.

Once bland, plant-based protein isolates have been obtained, the next challenge is to provide flavoring to these novel proteins that survives the finished product's manufacturing process and is acceptable over its shelflife.

We are learning that proteins are highly reactive food ingredients that form strong, stable bonds between selected amino acids



Some of the most nutritionally important amino acids, such as cysteine and lysine, are also very reactive with flavorings.

(most commonly lysine or cysteine) and flavoring molecules, Reineccius says. One can often initially flavor a protein-containing food product that meets consumer expectations, but that flavor deteriorates rapidly during shelflife. Today, we are questioning whether the end of shelflife of a product is due to the generation of off-flavors, such as from oxidation, or is it due to the loss of the desirable flavor reacting with the protein? Perhaps the loss of shelflife is a combination of both effects—the production of off-notes and the loss of desirable flavor components. Are we really able to determine the reason for the loss of desirable flavor and plan a strategy for mitigating the loss of shelf life?

We have a long history of working with dairy- and soy-based proteins, but we know little about how flavorings react with new proteins. We can assume that the amino acid composition of a new protein will indicate what reactivity it likely will have, based on the chemical reactivity of its individual amino acids.

However, very early data suggests protein structure can alter the chemical reactivity of amino acids. Unfortunately, we are also finding that some of our most nutritious proteins, such as lysine and cysteine mentioned earlier, are also the most reactive. At this time, we have much to learn, but fortunately, we also have the tools to be able to learn much more about protein-flavor reactions. These reactions can be measured using sophisticated mass spectrometry. Having a method makes studying and understanding possible.

Gary Reineccius, Ph.D., Professor and Past Department Head, Dept. of Food Science & Nutrition, University of Minnesota, greinecc@umn.edu.

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Using Chemistry to Solve Protein Flavoring Issues

ONE NEED NOT BE an industry veteran to know the consumer's bottom line is taste—and its close companion is flavor. Yet, as more proteins find their way into everything from sports beverages to energy bars, product developers face the attendant challenge of managing the flavor issues these in-demand ingredients present.

Robert J. McGorrin, Ph.D., department head and Jacobs-Root Professor, Food Science & Technology, Oregon State University, opened a door onto those challenges, as well as the fundamental underlying chemistry, and presented strategies for overcoming them, in his discussion, "Applying Chemistry to Solve Protein Flavoring Issues," given at the 2014 Protein Trends & Technologies Seminar. Prefacing his talk with the acknowledgment that flavor can make or break a product's commercial success and consumer acceptance, McGorrin quickly got down to explaining how and why product flavor goes wrong—whether by way of heat, processing, oxidation, pH fluctuations or interactions with other ingredients—namely, proteins.

It's not that proteins themselves contribute unwanted flavors—although volatile impurities in protein ingredients (and amino acids) certainly can. Rather, it is what happens when proteins bind, absorb, release or otherwise react with constituents of the product matrix—flavor ingredients, in particular. The off-notes that result are infamous among product developers, and McGorrin presented an inventory of classic flavor defects attributable to common protein sources and ingredients.

For instance, alcohol- and ketone-containing flavors might form hydrophobic bonds with the beta-lactoglobulin proteins in whey. While these bonds are largely reversible, more permanent covalent bonds can form between aldehydes, like the benzaldehyde responsible for cherry flavor, and the amino acid dipeptide aspartame in, say, an artificially sweetened soda. When this happens, McGorrin explained, what's known as a Schiff base forms, and over the soda's shelflife at room temperature, both the cherry character and its sweetness can disappear.

By analogy, the same types of Schiff reactions can occur between flavors and proteins. McGorrin also noted that sulfur-containing flavors, like mercaptans and thiols, can form disulfide bonds with the amino acids cysteine and methionine, yielding burnt-rubber and cabbage off-notes, particularly in retorted beverages. And, there are more reactions where those came from, all with sufficiently complex chemistry. As a rule of thumb, he said, flavor-binding strength and propensity are related to protein type, with soy and whey binding more readily than gelatin, casein or corn, generally speaking.

A "flavor congruency" approach might help mitigate general protein off-flavors. For example, peanut or nut flavors may have flavor profiles with similar "off" notes to some plant proteins. Or, co-opt the off-flavor as part of the intended profile. Green notes in a soy protein may round out a "jammy" strawberry—for a more true-to-fruit flavor.

Bringing matters back to the benchtop, McGorrin turned his focus to protein-boosted products—beverages in particular. He noted they are on the more challenging end of the formulation spectrum because of their high water activity (Aw) and being part of a "dynamic" product medium. Because protein beverages are normally thermally processed, flavors often change during heating, or are lost by reactions with other ingredients (flavor "scalping"). However, beverages also often have advantages regarding flavor stability since they are usually refrigerated.

McGorrin quoted colleagues who say formulators often have to use flavors "by the bucket-load"—upwards of four to 10 times the normal amount—to counter act losses and changes that take place in beverages formulated for high-protein content.

He then laid out four hypothetical challenges that high-protein formulations often face, and several strategies to address them:

1. Flavor congruency: When dealing with general protein off-flavors, consider following what McGorrin calls a flavor congruency approach—the formulation equivalent of "If you can't beat 'em, join 'em." In other words, if the challenge is an earthy pea protein or a beany soy protein, select a flavor profile that's supposed to include those "off" notes, like peanut or nut flavors. Or simply co-opt the off-flavor as part of the intended profile. In this case, a green note in a soy protein could round out a "jammy" strawberry into a more true-to-fruit flavor.

2. Soy's bitterness: When soy proteins encounter low pH levels, bitterness results. McGorrin credited vanilla and peach flavors with masking both that bitterness and soy's notorious beany notes. And, if the beverage can be processed either with high shear or nano-processing, he added, the improved emulsion stability will contribute creaminess and improve flavoring efficiency.

3. Bitter blocking: Another way of addressing bitterness, McGorrin went on, is to counterbalance it with increased sweetness. However, in an era of calorie restriction, that may not be an option. The solution here, he said, is to use bitter blockers that "distract" the senses from the bitterness. He listed sodium chloride, monosodium glutamate and adenosine monophosphate as examples, but noted that flavor houses can build proprietary solutions.

4. Avoiding astringency: When whey beverages drop below a certain pH—3.5 is often the cutoff—they can become astringent, which is the sensation that comes from the interaction of saliva proteins with constituents in the drink.

One hedge against this is to raise pH—but that introduces protein-stability and beverage clarity issues. Alternatively, McGorrin suggested adopting a tropical flavor profile, such as mango, pineapple and coconut, all of which can overcome bitterness.

Peach, citrus and apple can also counteract some astringency, he added.

Regardless of the challenge or solution, McGorrin recommended working with suppliers early and often in the R&D process. While one doesn't have to disclose deep formulation secrets, data about moisture content, pH, heat processing, storage conditions, percentage protein, and the addition of other vitamins, minerals and high-intensity sweeteners can help flavor partners put together a successful and efficient flavor solution that cuts time to market and makes good on both the promise of protein and a company's promise to its consumers.

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Trends in Snacks: Flavor, Flavor, Flavor

MOMENTUM IS ON THE UPSWING in the packaged snacks category, much of which is due to flavor innovation across both traditional snacks, as well as the up-and-coming alternative snacks segment. In fact, flavor—ranking at 67%—was the most critical driver among consumers' snacking choices, according to Mintel's "Trending Flavors and Ingredients in Snacks U.S., February 2020" report.

Double-digit growth in the snack market from 2018-2019 occurred in protein-oriented products, such as meat snacks (+29%), cheese snacks (39%), trail mix (20%) and the "other" snack category (38%) that includes bean-based snacks.

More than half of consumers (54%) claimed snacks are a good way to try new flavors without having to make too much of a commitment; 47% would try snacks made with flavors tasted previously at restaurants; and 36% like spicy flavors without heat (e.g., nutmeg, clove, cumin). Aside from classic flavors, such as barbecue, salt, garlic, ranch and jalapeño, consumers expressed an interest in herbs (e.g., rosemary, basil, lemongrass); vegetable (e.g., avocado, cassava, tamarind, pumpkin); and spicy flavors (e.g., sweet chili, sriracha). Unique combinations of flavors, such as spicy-sweet or sour-spicy, also have the potential to drive interest in emerging snack segments.

Flavor innovation is being driven by so-called disruptors from mainstream brands, as well as lifestyle diets like Keto and Paleo. Alternative

Grandpa's Cherry Chilli Beef Jerky is a hyrbrid flavor, combining the sweet fruit with the spicy chilli flavor.

chip eaters generally encompass the younger generations who seek healthier options and more unique flavors. Examples of such include Snacklins Miso Ginger Puffed Chips and LesserEvil Huevos Rancheros Grain Free Egg White Curls.

Consumer demand for ethically sourced protein has been one key driver of growth in the meat snacks category, including the pork rinds segment, which follows on the heels of high protein demand. According to Mintel, new product development rooted in flavor exploration has also spurred category growth. Examples of flavor innovation include Fusion Jerky Chili Basil Artisan Turkey Jerky, Duke's Hatch Green Chili Flavored Smoked Shorty Sausages, Pork Clouds Garlic Thyme Fried Pork Rinds and Field Trip Crispy Cuts Island BBQ Pork Rinds.

Although health, ethical concerns and indulgence are key drivers in the snacks segment, flavor is the primary indicator of consumer preference. And, snacks are the go-to products for consumers looking to try unique flavors. Therefore, when it comes to flavor innovation, the sky could very well be the limit.

—Paula Frank, Global Food Forums, Inc.

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Flavor Challenges with High Protein Levels

THE FLAVOR OF FOODS AND BEVERAGES brings out emotions and drives consumers' food choices. People have expectations for flavor, and if those expectations are not met, there is a problem. Functional foods often contain proteins and other ingredients that cause flavor problems.

"Linked to acceptance, flavor is the bottom line," spoke Keith Cadwallader, Ph.D., Professor, Department of Food Science and Human Nutrition at the University of Illinois at Urbana-Champaign, in his presentation "Flavor Challenges and Solutions for High Protein Functional Foods and Beverages" given at the 2015 Protein Trends & Technology Seminar. Defining flavor quality is especially important. "If a product is labeled as 'chocolate' or 'vanilla,' it needs to be identified as such immediately upon tasting," he advised.

If there is any confusion about that flavor, then it has failed. "The flavor should develop quickly, be balanced and get more desirable the longer it is tasted," added Cadwallader. Flavors also need compatible mouthfeel and texture. A chocolate beverage, for instance, should be creamy, viscous and thick—instead of watery or thin. Lack of off-flavors and minimal aftertaste are also important attributes for success.

Functional foods often contain ingredients that contribute harsh flavors and lack any inherent positive flavors. "Most people are not heard saying 'mmmm, taste that soy flavor,'" Cadwallader joked. While dairy proteins are generally pleasant, most functional ingredients are not. And functional beverages are seen by consumers as members of a food category, not a functional-food category, meaning a chocolate beverage will be compared to other chocolate beverages—not to other functional foods. Consumers do not forgive off-notes in foods and now expect high-quality functional beverages.

Proteins often have readily detectible, inherent off-flavors that are difficult to measure instrumentally. These off-flavors can often be attributed to enzyme-derived volatiles, aged proteins or lipid oxidation of bound lipids, Cadwallader went on to say. Soy protein isolate, for example, often has a fair amount of retained polar lipid that cannot be separated, leading to problems.

Soy protein is often associated with a well-known beany flavor and a "cereal note" generated from Maillard reactions that typically need to be covered. Dairy proteins are better—unless they are aged, when they can develop off-notes, unpleasant odors and astringency—problems in older caseins and whey protein concentrates.

"The fresher the protein, the better; if offered a deal on some old casein, the best option would be to pass," Cadwallader advised. As protein ages, off-notes form and bind to the proteins, which are often undetected until rehydration. Other protein off-notes include pea (earthy, soil), rice (bran, rancid), egg (sulfur) and insect (an "interesting" odor).

"Fat modulates flavor release, so adding even one drop of fat can make the world of difference," advised Cadwallader. Amazingly, 0.1% fat or less can completely shift the flavor profile. This lesson was learned years ago when trying to make everything low-fat or non-fat," he reminded the audience. Process-induced flavors are also an issue. A product may have the perfect flavor initially, but the process can change everything.

Cadwallader recommended first prescreening ingredients; looking for anything that might be a problem; and then, if needed, resourcing for better options. "Masking agents can also work like magic, in theory neutralizing undesirable aromatics and tastes, without imparting characteristics of their own—unless beneficial," he added.

Cadwallader suggested that a successful product is a balance between art and science. He strongly advised to work with a flavor company using non-disclosures; telling them everything about the formula, process and packaging. He recommended including flavor experts early, to provide them a product base and then challenge these experts to flavor it.

Fat modulates flavor release. Having even 0.1% fat or less can completely shift the flavor profile (in an otherwise fat-free product).

Keith Cadwallader, Ph.D., Professor, Department of Food Science and Human Nutrition at the University of Illinois at Urbana-Champaign, cadwlldr@illinois.edu, +1.217.333.5803, http://fshn.illinois.edu/directory/cadwlldr

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Are Natural Flavors Clean Label?

"ALL NATURAL" AND "CLEAN LABEL" do not necessarily equate with one another, began Deepthi K. Weerasinghe, Ph.D., Principal, dP3 Consulting, in his presentation "Formation of Flavor—Is Natural the same as Clean Label?" at the 2019 Clean Label Conference.

In the absence of a regulatory definition for clean label and only vague guidance by FDA and USDA as to what constitutes "natural flavor," such determinations are widely subjective.

So, what constitutes natural? To begin, raw plant and animal products have generally been accepted as "natural." However, their naturalness becomes subject to interpretation, depending on whether genetically modified organisms, pesticides, antibiotics and/or other chemicals were used in their production and handling. *Aspergillus oryzae*, for example, is a filamentous fungus used to produce soy sauce, miso and sake.

The growth media for *A. oryzae* cultures can be influenced to create lactones as flavoring compounds. "Since they are produced through natural fermentation, the lactones would be considered natural at that point, as they are not all that different from other products of fermentation, such as beer, yogurt, bread or cheese," said Weerasinghe. But what happens when one starts genetically altering the enzymatic components of fermentative microorganisms?

A demarcation between "soft" vs. "hard" chemistry may also define what is natural. Weerasinghe noted that the flavor industry had contended with this issue years ago with hydrolyzed vegetable proteins (HVP). While initially manufactured using "hard" inorganic chemicals to hydrolyze the proteins into amino acid-based flavor enhancers, consumer influences shifted the industry toward using natural enzyme-catalyzed hydrolyses (i.e., "soft" chemistry).

This demarcation may be less clear-cut today, especially under more restrictive EU regulations, said Weersinghe. "Soft chemistry also refers to processing methods similar to common kitchen practices," explained Weerasinghe, as in the use of juice concentrates and heat to alter pH conditions.

Weerasinghe pointed to a patent describing the production of aliphatic alcohols and aldehydes from vegetable oils using enzymes naturally present in guava juices and soy flour. He noted that "The methodology used to extract and purify such enzymes will factor into their regulatory and clean label designations."

A demarcation between "soft" vs. "hard" chemistry may define what is natural. For example, an alternative to a manufacturing process that uses "hard" inorganic chemicals for hydrolysis would be the use of enzyme-catalyzed hydrolyses (i.e., "soft" chemistry).

The types of flavor extraction processes used also impact natural label designations. It makes a difference, he noted, if flavors are extracted with water, with ethanol (tinctures), or with natural oils or organic chemical solvents (oleoresins). Vanilla extractions typically use ethanol and water. However, the U.S. Code of Federal Regulations (CFR) also allows the use of glycerin, propylene glycol, sugar, dextrose and corn syrup in such extractions. Such minor extraction-process modifications could ultimately affect label designations.

Processed flavors, which rely on Maillard reactions and Strecker degradations to produce savory flavors, are regulated in terms of process conditions (temperature, time, raw materials) to determine what constitutes natural. In the EU, they must be called "processed flavors." But their appeal also lies in the ability to create vegan meat flavors from vegetable proteins. "You can make a wide range of chicken or beef flavors without using animal proteins," said Weerasinghe.

Whether or not they qualify as natural or clean label will depend upon both regulatory authorities—and where vegan consumers are willing to accept trade-offs.

"Customers today are looking for safety; many are looking for comfort," concluded Weerasinghe. "The question remains: Are regulatory environments helping or hurting such aspirations?"

Deepthi K. Weerasinghe, Ph.D., Principal, dP3 Consulting

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For more than 120 years, we have been delivering powerful, memorable taste and aroma experiences across the globe. **Firmenich** is always ready to tackle complex flavor and nutritional challenges with our technologies, with a goal of ensuring consumer preference, every time. We continue to lead the way in helping to make healthier food & beverages taste great with our breakthrough taste modulation tools. Our solutions improve flavor release, reduce bitterness and mask off-notes across all protein applications. To ensure we are meeting the needs of even the most discerning customers, we follow a proprietary process to design the best products across categories. www.firmenich.com/en_INT/flavors.html

Flavor Insights is a West Coast flavor boutique with a sweet spot in sport nutrition and protein. Our flavor and formulation team have a proven track record of creating some of the most successful and innovative national brands in the sport supplement and beverage arena, while operating with the flexibility and responsiveness of a family-run business. www.flavorinsights.net/

Crafting with a palette of nature's ingredients, **Flavor Producers** has been artfully deconstructing natural and organic taste for over 30 years. Driven by our creative spirit and a passion for discovering the flavors of nature, Flavor Producers has established one of the largest certified-organic, plant-based flavor portfolios in the industry. Our newest breakthrough technology, Rutz™ utilizes the power of plants to showcase the flavors of nature in their most transparent form. www.flavorproducers.com/

Givaudan is the global leader in the creation of flavors, tastes and kitchen ingredients. In close collaboration with food & beverage partners, it develops tastes that delight consumers the world over. Strategically focused on health and wellbeing, Givaudan is investing in advanced solutions for flavorful plant-based foods, high-protein products and next-generation protein sources. With a relentless drive to innovate, Givaudan is at the forefront of creating flavors that "engage your senses." www.givaudan.com/flavours/health-and-well-being/protein

Brookside Flavors & Ingredients: "Healthy, Natural, Good for You!" We offer food and beverage manufacturers a clean label and a healthier, natural way to flavor their products. Savory or sweet, we have you covered! Our diverse palette of organic and conventional flavors and ingredients will meet your needs with our Yeast Blends, USDA Flavors, Seafood Flavors, Vegan Flavors, Flavor Enhancements, Spice Extracts, Floral Extracts, Citrus Extracts. Let's work together to build the flavor profile you need. www.brooksideflavors.com

Virginia Dare delivers preferred taste with extracts, flavors, taste refinement systems and product development. Extracts and concentrates include our core four—vanilla, tea, coffee, cocoa—plus clean label fruit and botanical extracts. We create flavor profile types including sweet, spicy, sour, bitter, fruity, exotic, botanical, spice, nutty, café and alcohol. We refine taste with masking, modulation, sweetness, smoothing, impact and texture. Product development encompasses beverages (alcohol and non-alcoholic), sweet foods/snacks, dairy and dairy-alternatives, pharma and oral care. www.virginiadare.com

FCI Flavors provides superior quality flavors to the supplement, natural foods and functional foods industries. FlavorSweet® is an all-natural masking agent and flavor enhancer. It is excellent for masking off-notes associated with vitamins, minerals, amino acids, herbal extracts and high-intensity sweeteners. FlavorSweet® has a clean, slightly sweet profile that works well with most flavor systems and is label-friendly. FlavorSweet® is now available USDA Organic. www.fciflavors.com/

The 2021 Protein Trends & Technologies Seminar has been re-scheduled for May 25-26, at the Westin Hotel, Itasca, Ill. (a suburb of Chicago). Most all speakers originally scheduled for the 2020 event have been reconfirmed. The two-day 2021 event will again consist of a Pre-conference Program: Protein Business Strategies followed on the next day by the Technical Program: Formulating with Proteins. Please visit www.globalfoodforums.com/2021-protein-seminar for updates.

The Effect of Color on Flavor Perception

CLEAN LABELING EFFORTS may mean colorants will be avoided, yet color may prove essential in capturing how consumers perceive a food product, noted Debra Zellner, Ph.D., Professor of Psychology at Montclair State University, and Affiliated Faculty Member at Monell Chemical Senses Center. Zellner provided an illuminating discussion of how the color of food (and its packaging) affects consumers' expectations for odor and flavor in her presentation: "The Effect of Color on Odor Perception: Toward More Efficient Ingredient Use" that was presented at the 2019 Clean Label Conference.

The odor associated with food is perceived orthonasally (when detecting the food's aroma) or retronasally (when food is in your mouth, i.e., "flavor"). Food color affects the perceived intensity of orthonasal odor, with colored foods (regardless of color) rated as having more intense odors than clear foods. In contrast, colored foods were perceived retronasally as less intense than clear foods.

Food color also affects flavor identification, which in turn affects how well a consumer likes a food. "Most people are terrible at identifying flavors or odors," commented Zellner. If the flavor and color of a food are incongruent, subjects will perceive the flavor to be something congruent with color. For example, a clear cola soda might be perceived as lemon/lime rather than cola.

How well a color matches the flavor of a food also affects how well the food is liked, with foods less well-liked when their flavor and color are incongruent—unless it is apparent what the flavor is supposed to be. As explained by Zellner, "Green beer is still okay on St. Patrick's Day," because you know the beverage tastes like actual beer—not mint or apple.

Zellner detailed some of the psychology underlying these results. When stimuli are paired together repeatedly over time, an association between them develops. For example, if you are a coffee drinker, a brown-colored beverage will elicit the perception of coffee. The odor perception due to the color alone is similar but weaker than that produced by the actual stimulus [i.e., coffee aroma], but color can add to and enhance the actual odor.

One recent study tested how a raspberry/lemon-flavored beverage was perceived when colored yellow, red or left clear. When colored yellow, the soda had more of lemon aroma than did the same beverage when red or clear in color. The effect was limited to the scent, however, because the color did not influence the perceived taste of the beverage

Inspired by *New York Times* food critic Mimi Sheraton, Zellner's group also investigated whether packaging color provides a clue to the flavor of the food inside. Unflavored, neutral-colored hard candies were wrapped in various colored papers. When still wrapped, the color of the wrapper influenced what flavor the subjects believed the candies were. After unwrapping, however, the wrapper color did not affect the flavor subjects assigned to the candy. Most subjects predicted that unwrapped, neutral-colored candies were mint, vanilla or coconut in flavor. The perceived flavor when tasting the uncolored candy was often vanilla or butterscotch, flavors normally associated with neutral colors.

In summary, food or packaging color can influence odor or taste perception or expectation in a variety of ways. Food color increases orthonasal (sniff) but not retronasal (in the mouth) odor perception; color can intensify one odor component in a complex product with multiple odors; color does not increase flavor intensity, but color will change expectation, identification and enjoyment of a flavor.

Debra Zellner, Ph.D., Professor, Psychology, Montclair State University & Monell Chemical Senses Center

PHOTO CREDIT: NEW AFRICA/SHUTTERSTOCK.COM

A food may be less well-liked when its flavor and color are incongruent, unless it is apparent what the flavor is supposed to be. For example, green beer is acceptable on St. Patrick's Day.

Knowledge leads to great taste

The range and availability of alternative proteins continues to grow, and so do the taste challenges that often come along with them.

Whether creating a nutritional beverage or a meat substitute, exceeding customer expectations means understanding taste, texture, moisture, mouthfeel, color, aroma and other product attributes.

Givaudan has you covered.

We can help you improve palatability with natural, consumer-friendly solutions.

Putting the Pro in Protein.

Givaudan

engage your senses

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