2021 Clean Label

Post-Webinar Magazine

Technical Solutions in Formulating Clean Label Food

What's Inside...

- Consumer Perception of Food Ingredients
- Tips When Formulating with Hydrocolloids
- Natural Colorants: Using Them Successfully
- Sponsors

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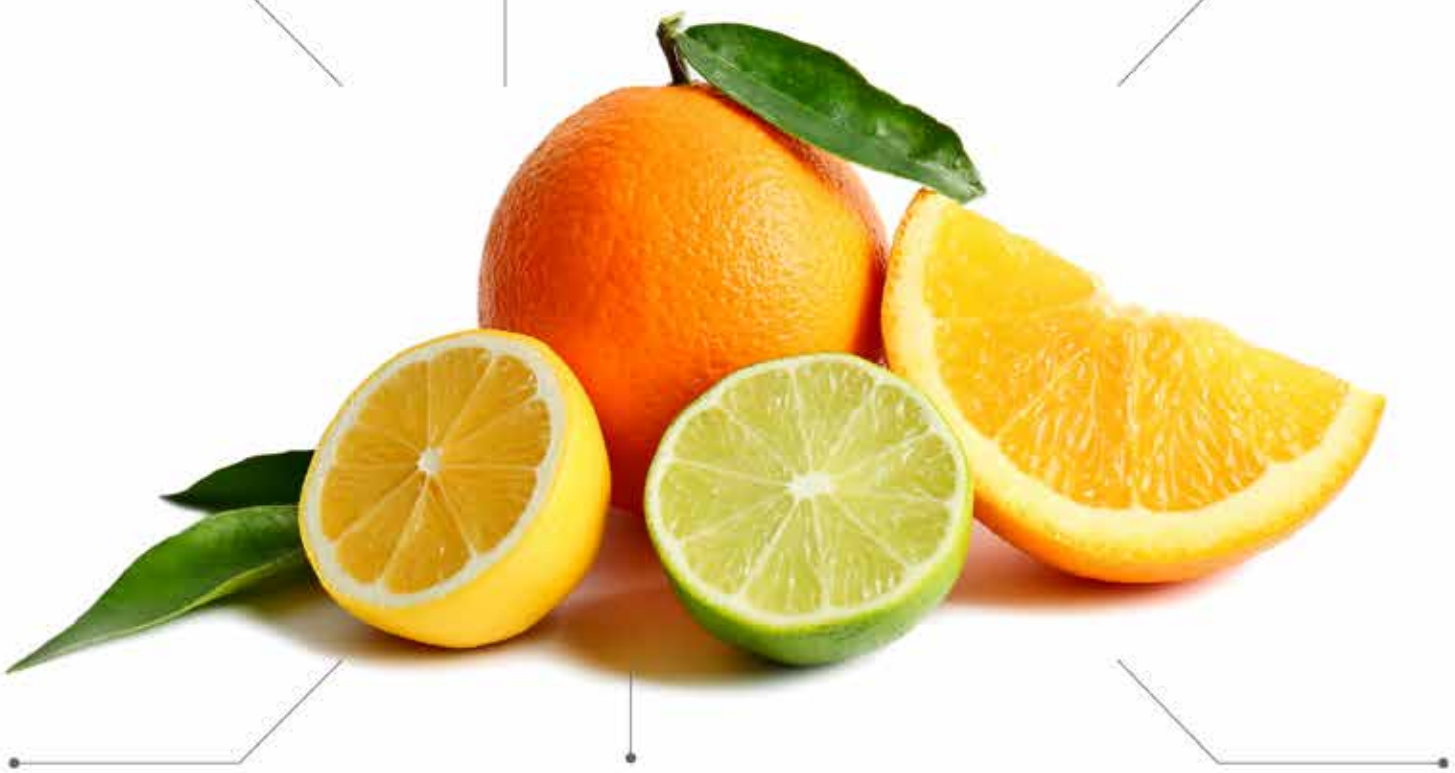

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2021 Clean Label Premium Webinar Magazine

During the pandemic, Global Food Forums continued to provide technical information on ingredients, formulations, as well as food trends. We have done so by offering a series of webinars on clean labels, proteins, sweeteners and other ingredient-specific technologies. This magazine focuses on our 2021 Clean Label Premium Webinar. For those of you who miss in-person networking with industry peers, please join us for our 2022 Clean Label Conference that will take place on May 24-25, in Itasca, Illinois, a Chicago suburb northwest of O'Hare International airport. See https://bit.ly/31Y2c5h.

Warm regards,

Claudia O'Donnell & Peter Havens

Co-owners, Global Food Forums, Inc

2021 Clean Label Premium Webinar Magazine

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Consumers' Ingredient Awareness on the Rise

SURVEY DATA gathered by the International Food Information Council (IFIC) showed consumers' ingredient awareness is on the rise. Tony Flood, Sr. Director, Ingredient Communications, IFIC, emphasized this point in his webinar titled "Consumer Perception of Food Ingredients," presented at Global Food Forums' 2021 Clean Label Premium Webinar.

Flood gathered information from several surveys conducted by IFIC[1], each with 1,000 or more participants from American households. Interviews—conducted with adults 18 and over, were weighted to ensure proportional results regarding age, race, gender and income. The results of these surveys paint a picture of consumers' attitudes toward diet, health and food safety. This presentation focused on consumer trends concerning clean eating.

Consumer interviews conducted in 2018 in Baltimore, MD, titled "Clean Eating Values Among Millennials and Gen Z,"[2] relied on focus-group discussions to assess these groups' insight into clean eating. Back in 2018, participants were not highly aware of "clean" and were not willing to accept trade-offs in taste, price and convenience for clean ingredients.

In a 2019 internal IFIC survey among Registered Dieticians (RDs) on clean eating perspectives, the RDs claimed they were discussing clean eating up to four times per week with their clients. In addition, they found they were seeking consumer-friendly resources on clean eating.

A mere two years later, more consumers seemingly grasp the clean eating concept, given the results of IFIC's survey titled "'Chemical Sounding' to 'Clean': Consumer Perspectives on Food Ingredients, 2021."[3] Nearly half of Americans (46%) consider themselves "clean eaters;" among those clean eaters, 49% define clean as "not highly processed," noted Flood.

WHICH INGREDIENTS ARE CONSIDERED "CLEAN"

Regarding ingredient choices, 64% of those in the survey try to choose foods with clean ingredients. How did survey respondents define clean ingredients? Most people said they avoid ingredients with chemical-sounding names and those that are highly processed—preferring those with simple ingredient lists, fresh, natural, organic and those perceived as nutritious. Among those that seek out clean ingredients, a quarter said health benefits were the top motivator, emphasized Flood. Of the 56% who avoid ingredients with chemical-sounding names, 64% of them cited the reason as perceived health concerns, he added.

"When consumers are asked for their safety concerns regarding food ingredients in the Food & Health Survey, we find they can't list them by name," said IFIC's Anthony Flood. And, "If we list a particular food chemical or compound by name, consumers will respond to that in a negative manner."

When asked for examples of chemical-sounding names by a webinar attendee, Flood mentioned that IFIC's surveys are broad in scope intentionally, so consumers can answer certain questions for themselves. "When consumers are asked for their safety concerns regarding food ingredients in the Food & Health Survey, we find they can't list them by name," said Flood. "If we list a particular food chemical or compound by name, consumers will respond to that in a negative manner," he added.

Survey results revealed that "the words 'natural' and 'artificial' evoke strong reactions around food choices. About half of Americans say they seek out natural flavors at least some of the time; 41% seek out natural sweeteners; 40% seek out natural preservatives; and 35% seek out colors from natural sources. In contrast, artificial flavors, colors, sweeteners and preservatives were sought by only about one in 10 consumers, with approximately half saying they avoid each of them at least some of the time," said Flood.

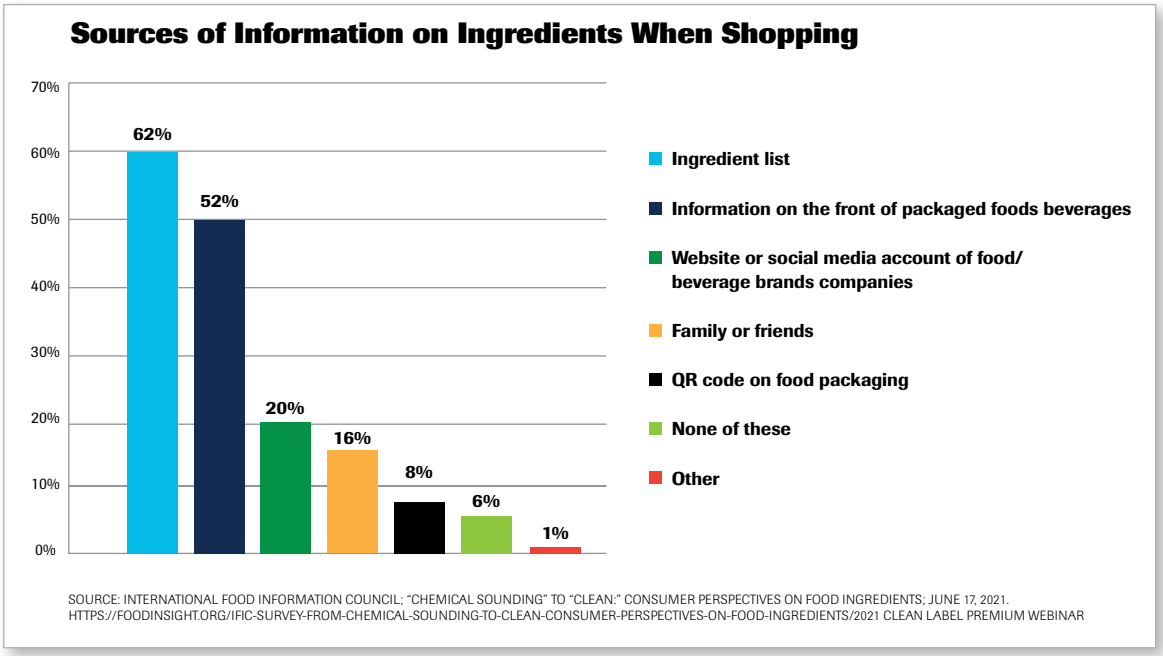
Flood presented data showing a significant difference among those with college degrees vs. those without in regard to artificial ingredients, with the former more likely to "at least sometimes" avoid these ingredients. However, there was no significant difference between men vs. women, income and race. These results are as follows:

- Artificial sweeteners (60% college vs. 43% non-college)
- Artificial colors (55% college vs. 41% non-college)
- Artificial flavors (52% college vs. 40% non-college)
- Artificial preservatives (55% vs. 42% non-college)

The survey did, however, uncover interesting data on consumers' opinions on preservatives. While consumers who choose clean

ingredients generally avoid chemical-sounding ingredients, the survey found 42% "agree that adding preservatives to foods is a way to help reduce food waste (21% disagree), and 39% agree that adding an ingredient to a food would be positive if it extended shelflife (23% disagree).

Consumers may seemingly consider animal welfare and sustainability part of clean eating. When asked how we (as food professionals) reconcile consumers' push for meat alternatives that contain lesser-known ingredients, Flood noted that, from discussions and survey data he's seen, "Individuals who want meat



SOURCE: INTERNATIONAL FOOD INFORMATION COUNCIL; "CHEMICAL SOUNDING" TO "CLEAN:" CONSUMER PERSPECTIVES ON FOOD INGREDIENTS; JUNE 17, 2021. HTTPS://FOODINSIGHT.ORG/IFIC-SURVEY-FROM-CHEMICAL-SOUNDING-TO-CLEAN-CONSUMER-PERSPECTIVES-ON-FOOD-INGREDIENTS/2021 CLEAN LABEL PREMIUM WEBINAR

Consumers find information on the ingredients from multiple sources. The ingredient list is the primary source of information. Some 8% find QR codes useful.

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alternatives aren't necessarily concerned with ingredients (per se). I think they're more concerned with (animal welfare) or sustainability or other holistic issues," he added.

THE IMPORTANCE OF "PROCESSED"

As previously mentioned, consumers interested in clean eating tend to avoid foods that are highly processed. IFIC's July 2021 survey, "Perceptions on Processed: Consumer Sentiment and Purchasing Habits,"[4] ties in nicely with its survey conducted in May 2021 on consumers' perception of food ingredients.

One of the key highlights in the survey on processed foods is that "many…are more likely to buy a processed food or beverage if it is high in protein, enriched or fortified with vitamins and minerals, and has natural flavors/colors." It is interesting to note that similar levels of processing-related concerns are consistent across various food and beverage categories.

Also of interest is that taste, price and healthfulness are the top-ranked purchase drivers when grocery shopping, regardless of whether the product is processed or not. These same purchase drivers were mentioned in the 2018 survey on clean-eating values.

The in-depth surveys done by IFIC have important implications for the food industry—particularly for product developers and other key food and beverage industry stakeholders. IFIC's collaboration with RDs results in the "development of consumer-friendly resources, so the RDs can help answer questions they get from their constituents. Strategic collaborations are important in helping provide consumers with science-based information," explained Flood.

Consumers with science-based information can help food scientists deliver products that align more closely with their values and demand, such as clean eating—if those products meet expectations for taste, price and healthfulness.

1) https://foodinsight.org/
2)https://foodinsight.org/report-summary-clean-label-values-among-millennials-and-generation-z/
3)https://foodinsight.org/ific-survey-from-chemical-sounding-to-clean-consumer-perspectives-on-food-ingredients/
4)https://foodinsight.org/perceptions-on-processed-consumer-survey/
To access the video and PowerPoint of this presentation, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/consumer-attitudes-towards-food-ingredients-presentation/ or https://bit.ly/3Klt68y

"Consumer Perception of Food Ingredients," Anthony Flood, Sr. Director, Ingredient Communications, IFIC

Hydrocolloid Functionality for Product Developers

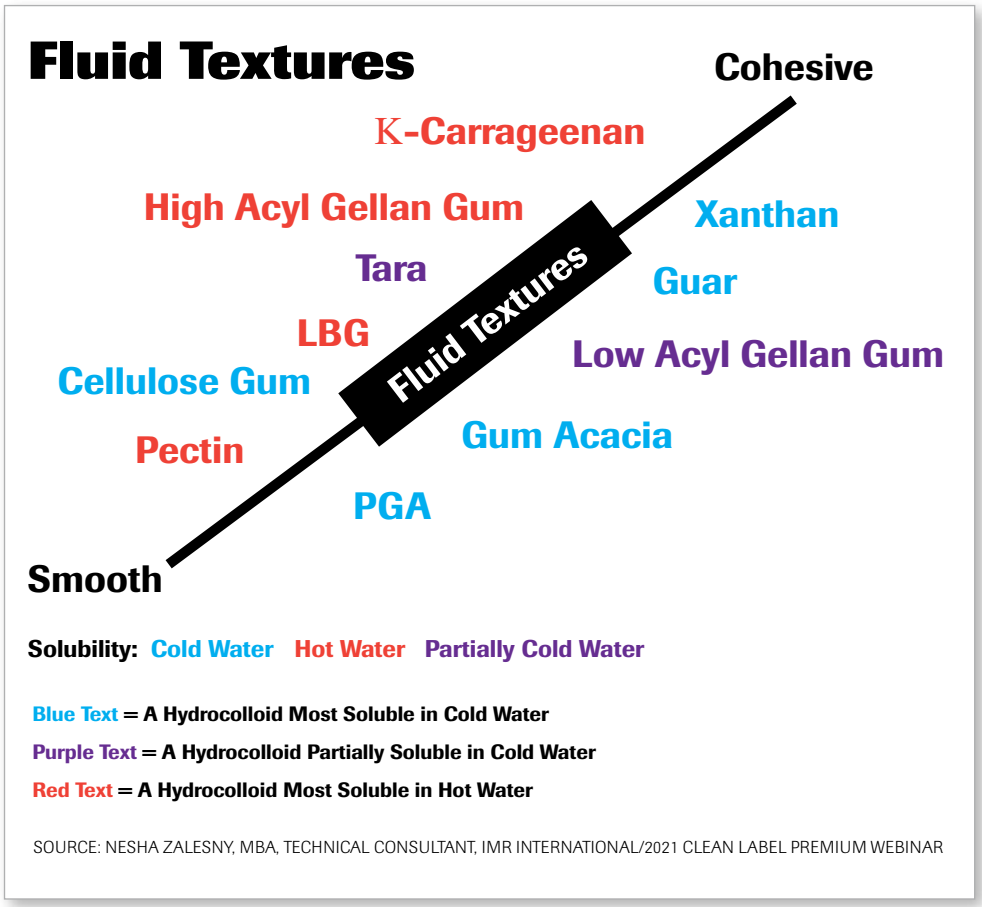
HYDROCOLLOID FUNCTIONALITY for product developers was addressed in a presentation given for Global Food Forums' 2021 Clean Label Premium Webinar by Nesha Zalesny, MBA, Technical Consultant, IMR International. Titled "Tips, Tricks & Tradeoffs When Formulating with Hydrocolloids," the webinar covered topics such as chemical structure, texture, ingredient interactions, stability, processing and pricing.

Hydrocolloids are long chains of polysaccharides comprising a backbone and side chains of methoxy or carboxyl groups or sugars. These functional groups give hydrocolloids interesting properties, noted Zalesny, who proceeded to give an example using xanthan gum. Xanthan gum's side chains of sugars wrap around its backbone—protecting the backbone from acid hydrolysis, making, it extremely acid-stable.

Inversely, locust bean gum (LBG) is a long chain composed of a mannose backbone with a blocky galactose-side chain. LBG's side chains do not protect its backbone from acid hydrolysis, which is a consideration if a longer shelflife (or a lower pH) is desired, mentioned Zalesny. This is also true of the cellulosics, she added.

Gelatin is also a hydrocolloid composed of a triple-helix protein structure. It is the folding of the protein that gives gelatin its functionality.

If you want a smooth flow or a little bit of body to make up for the lack of bulk from sugar, such as in a reduced sugar fruit juice, then pectin and gum acacia are excellent, advised Zalesny.



As a product developer, the question you need to ask yourself is whether you want a smooth flow or a little bit of body. "A reduced-sugar beverage formula for a fruit juice may need a little bit of body to make up for the lack of the bulk of sugar, of which pectin and gum acacia are excellent," suggested Zalesny.

If the desired texture of a formulation is more like salad dressing, a selection from the more cohesive end of the spectrum would be required. Xanthan gum, when used at a low concentration, produces a nice, smooth flow. However, when used at a high concentration, the texture can become quite "snotty."

"Most gelling agents require heat for hydration. The exception may be hydroxypropyl methylcellulose (HPMC) or methylcellulose (MC) that are used in plant-based meats and some gluten-free bakery," said Zalesny. (See chart "Gel Textures")

What is the product developers' goal regarding gel textures? Should the finished product have a soft, flexible, wobbly gel or a firm, brittle gel, as shown on the continuum?

HYDROCOLLOIDS AND TEXTURE

Viscosity, gelling, suspension and emulsifying are all textural properties associated with hydrocolloids. Some hydrocolloids exhibit different properties under different conditions, particularly when combined. Xanthan and LBG are two such examples. By themselves, they just add viscosity, but when you blend them together and add heat, they form a gel.

Some hydrocolloids are concentration dependent. Carrageenan, for instance, will form a fluid gel at low concentrations, but at high concentrations, the gel will be more rigid. Other hydrocolloids act as suspension agents and form gels while sitting on a shelf but "break up nicely and form a light, refreshing beverage" when poured or placed in the mouth, as with carrageenan and high acyl (HA) gellan, described Zalesny.

Viscosity may be shear-dependent for certain gums. Xanthan gum has a high low-shear viscosity, but a higher high-shear viscosity. This means a beverage made with xanthan gum will have a higher viscosity when consumed, which is less refreshing.

INGREDIENT INTERACTIONS AND SENSITIVITIES

A number of ingredient interactions can occur during product formulation—both positive and negative. A lot of hydrocolloids are ionic in nature and will therefore interact with ions that come from other ingredients, including water. Iota carrageenan, for instance, requires calcium ions for gel setting.

Aside from ion sensitivity, hydrocolloids may have a solids requirement or act synergistically or antagonistically with other ingredients. High methoxy (HM) pectin has a solids requirement of ≥55%, so enough sugar must be used to get full functionality out of the HM pectin in applications such as jams, jellies or fruit fillings.

Carrageenan interacts with protein, forming a synergistic network that's beneficial in milk and plant-based products. Other examples of synergies include pectin and alginate, which are "extremely synergistic with one another and form excellent bake-stable fruit fillings," said Zalesny.

The combination of gelatin and pectin forms an antagonistic reaction, keeping the gel from becoming too cohesive. Some companies intentionally use these ingredients to produce gummy bears with a less cohesive texture.

"A lot of hydrocolloids are sensitive to acid hydrolysis in their open configuration (hot and in-solution before they set [e.g., carrageenan, gelatin]). Adding acid at the wrong step can be very detrimental to

texture," said Zalesny. "The opposite can be true where some hydrocolloids don't care for neutral/basic environments (e.g., pectin, HA gellan). These ionic conditions will modify the finished texture of the gum if they sit in hot and neutral/basic conditions," she added.

TRICKS AND TRADEOFFS

It's imperative that the best stabilizer is chosen for the system and process. For instance, is increased thermostability required? For example, will a product such as a fruit prep—that already has been exposed to thermal gelation—be exposed to heat a second time when used in a baking application?

Incorporation of the hydrocolloid is also critical, as it should be hydrated completely and optimally, and added upfront, noted Zalesny. In cold-water applications, the hydrocolloids should be blended with other ingredients and used with dispersing agents to prevent "fisheyes" from forming.

"Identify the optimal use level 'window' and try to stay within it," emphasized Zalesny. "For example, use of carrageenan in milk at a level of 0.018% is optimal, but if used at .025%-.030%, it will form a bit of a gel, and you'll get a very unpleasant flow," she added.

She also recommended adding acid as the last step, which will help prevent acid hydrolysis of the hydrocolloids in their open conformation.

In terms of tradeoffs, "rarely is there a 'this or that' drop-in solution. They're very unique in functionality," said Zalesny. Pay attention to cost-in-use. Even though starch may be able to replace a hydrocolloid, the quantity needed will be greater; and there may be flavor implications.

HMC and HPMC are the only hydrocolloids that thermally gel, so the gel sets when they're hot and melt as they cool, making these gums difficult to replace in meat alternatives. While Zalesny is aware that thermostable gels can perhaps be made with alginate or konjac as a replacement for MC in meat analogs, something else would be needed to replace the succulence, such as xanthan, guar or tara gum. "There's nothing that does exactly what MC does. You can only approximate the functionality with combinations of other solutions," she said.

Zalesny concluded by encouraging product developers to explore various uses of these functional ingredients: "Different textures can be achieved by mixing some of these hydrocolloids—synergisms that have only begun to be used in the food industry."

"To access the video and PowerPoint of this presentation, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/formulating-with-hydrocolloids-tips-tradeoffs-presentation/ or https://bit.ly/3FmrKGF

"Tips, Tricks & Tradeoffs When Formulating with Hydrocolloids," Nesha Zalesny, MBA, Technical Consultant, IMR International

Understanding Natural Food Colorants

WINSTON BOYD, PH.D., Principal Consultant and Owner, Earthwise Technology, provided valuable insight toward a better understanding of natural food colorants in his presentation titled "Natural Colorants: The Opportunities and Challenges in Using Them Successfully," given at Global Food Forums' 2021 Clean Label Premium Webinar.

Boyd focused on three specific colorant classes—betalains (e.g., red beet juice), carotenoids and curcuminoids (e.g., turmeric). Time prevented a detailed discussion of additional natural colorant classes, including anthocyanins, anthraquinones and chlorophylls, among others.

Although natural colorants are very safe to use, they may not behave in predictable ways. As a product developer, it is beneficial to have a thorough understanding of their properties and functionality in a wide range of applications—from formulation through processing, storage, distribution and shelflife.

BETALAINS

Betalains represent the class of pigments that produce berry-like colors. Commercial preparations of betalains are generally prepared from red beets (*Beta vulgaris*), although they can be derived from cactus pear fruit and pokeweed berries.

The two most important coloring molecules in red beet juice are betanin and vulgaxanthin II. The later, a yellow color, is overwhelmed by the red-violet shades of betanin in beet juice. It is the conjugation of single and double bonds in these chromophores that is responsible for their respective colors, noted Boyd.

Betalains are commonly known to be susceptible to temperature abuse. In addition, the betanin structure is particularly

In gummy candy manufacturing, if the gummy mass is held above 200°F for 2-3 hours, the color degrades over time. Gummies produced early in the run will be darker than the ones produced later.

Impact of pH on Betalain Color

SOURCE: WINSTON BOYD, PH.D., PRINCIPAL CONSULTANT, OWNER, EARTHWISE TECHNOLOGY/2021 CLEAN LABEL PREMIUM WEBINAR

Betalains, such as red beet juice, are susceptible to alkaline pH which, when combined with the heat of baking, resulted in color degradation (center muffin). A more acidic pH prevented color degradation under the same baking conditions (righthand muffin).

sensitive to hydrolysis in the presence of water. "This reaction is accelerated by heat in unfavorable pH conditions," explained Boyd, who proceeded to demonstrate the effect of pH on red beet juice in a baking application.

In a study, a simple white cake formula prepared as a muffin represented the control as the first variable. In the second variable, 1/8-tsp of baking soda and red beet juice were added to the white cake formula. In the third variable, 2 tsp of white vinegar and red beet juice were added to the formula. (See image "Impact of pH on Betalain Color.")

Results showed that the slight alkalinity in the second variable, due to the chemical leaving agent combined with the heat of baking, destroyed the red color. By lowering the pH with vinegar in the third variable, much of the red color survived under the same baking conditions.

Based on the results of this simple study and what is known of how betalains react to adverse conditions, Boyd recommended the following solutions: control both the intensity and length of heat exposure; modify the pH of the matrix when necessary; and use betalains, such as red beet juice, in low water-activity systems, which can survive very high temperatures for extended periods of time because of the limited availability of water.

CURCUMINOIDS

Curcumin, (derived from the word "curcuminoids") is isolated from the rhizome of the *Curcuma longa* plant. The structure of the curcuminoid chromophore is responsible for the vivid yellow color for which curcumin is known. However, curcumin is quite light-sensitive and is therefore used in applications where extended light exposure can be avoided.

Boyd created a simple experiment to demonstrate the properties of curcumin. Two different oleoresin (OR) turmeric preparations were mixed in water and placed in clear glass bottles. One solution was cloudier than the other due to its formulation. The clear solution contained a more water-dispersible version of OR turmeric.

After four hours in direct sunlight at 90°F, the clear solution was nearly decolorized. The solution that was originally cloudy retained some color but lost quite of bit of its intensity and was no longer cloudy. After 12 hours in direct sunlight at 90°F, the clear solution was completely decolorized, and the other solution retained little of its original color.

This experiment showed the type of curcumin formulation can influence its stability over time. Although the cloudiness of the solution offered some protection against the harmful effect of sunlight, both solutions faded quickly, demonstrating just how sensitive curcumin is to the destructive effects of sunlight.

When using curcumin, Boyd recommended eliminating light exposure as much as possible and keeping the pH between 2.5 and 7.0. Unfortunately, no oxidative additives exist that can be used to extend the shelflife of curcumin, noted Boyd. "The best bet is physical protection from light," he added.

CAROTENOIDS

More commonly known sources of carotenoids include algae, annatto, carrots, marigold, palm, paprika (*Capsicum annum*), saffron and tomato, among others. Carotenoids can also be made via synthesis. A natural form of β-carotene, for example, can be derived from the salt-tolerant algae *Dunaliella salina*, from carrots and from the fungus *Blakeslea trispora*.

"The structure of carotenoids is characterized by a conjugated system of single and double bonds in a chain, which forms the chromophore responsible for the unique color of each molecule," noted Boyd. Many carotenoids are oil-soluble, but some are water-soluble, depending on the end groups. Water-dispersible preparations of the oil-soluble carotenoids can be made using food-grade surfactants, such as gum Arabic, he continued.

Carotenoids are susceptible to light, oxygen, pH extremes and heat. Boyd's third experiment demonstrated these sensitivities. Oleoresin paprika (ORP), specifically 40,000 CU ORP, was

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Global Food Forums' Webinars

We are pleased to introduce our recent webinars in the areas of clean label, food proteins and sweeteners. These webinars provide insights into key consumer and food product trends and address technical formulation issues.

https://globalfoodforums.com/global-food-forums-webinars/

spread on coarse salt; the same was repeated but with vitamin E added as a sacrificial antioxidant; and ORP was spray-dried on maltodextrin and modified food starch, thereby encapsulating it and protecting it from harsh conditions.

After nine hours in direct sunlight at 90°F, the unprotected ORP showed signs of decolorization. The ORP with vitamin E showed very little, if any degradation, which demonstrated the power of using sacrificial antioxidants to stabilize the color of carotenoids under these conditions. The encapsulated ORP showed little change.

Boyd provided the following solutions for successful use of carotenoids: control light exposure; keep the pH in the proper range; and minimize oxygen exposure by using sacrificial antioxidants.

As shown, many factors can influence the performance of natural colors. Boyd provided additional examples as follows: "pH can affect colorants' solubility, making them unstable for use in more acidic foods and beverages; low doses of ascorbic acid in beverages (≤90ppm) can be antioxidative, while higher concentrations can be aggressively pro-oxidative; and trivalent iron (Fe3+) can cause rapid and dramatic degradation to color systems, causing a complete loss of color in a short time."

Knowledge of natural colorants' sensitivities, as well as optimal solutions for formulating with success, will help product developers produce foods and beverages that meet consumers' expectations of quality. "Today, more than ever, consumers expect their food will be prepared with ingredients and additives they'll understand—making natural food colorants more relevant than ever," concluded Boyd.

For access to the video and PowerPoint of this presentation, see https://cleanlabel.globalfoodforums.com/clean-label-rd-academy/using-natural-colorants-successfully-presentation or go to https://bit.ly/3IkzKdt

"Natural Colorants: The Opportunities and Challenges in Using Them Successfully," Winston Boyd, Ph.D., Principal Consultant and Owner, Earthwise Technology

Global Food Forums greatly appreciates the sponsors and speakers at our 2021 Clean Label Premium Webinar. For those of you who would like more information on current hot topics and technical advice in the area of clean labels and who miss in-person events, we'd love to see you at our 2022 Clean Label Conference in Itasca, Ill., a suburb northwest of Chicago's O'Hare airport. See https://cleanlabel.globalfoodforums.com/clean-label-events/2022-clean-label-conference/ or https://cleanlabel.globalfoodforums.com/program/

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