2015 Clean Label Conference

A Conference Report Sponsored by:

- Loders Croklaan
- RiceBran Technologies
- SunOpta

2015 CLEAN LABEL CONFERENCE

Sophisticated Solutions for Simplified Labels

Strong global consumer demands and the desire for operational and distribution efficiencies drive interest in foods with simple, easy-to-understand ingredients. Advances in food science assist food manufacturers in achieving this goal. On March 31-April 1, 2015, Global Food Forums, Inc.'s Clean Label Conference technical program drew a record 220 registrants. Eleven expert, non-commercial speakers delivered practical formulation advice on developing foods with simple, consumer-friendly ingredients. In addition, 18 jury-selected Technology Snapshot presentations gave information on new clean label ingredients. This Special Report provides presentation highpoints. Presentations are available for download at http://www.GlobalFoodForums.com/2015-Clean-Label/Store. We look forward to seeing you at the 2016 Clean Label Conference on March 29-30, 2016, Itasca, Illinois, USA.

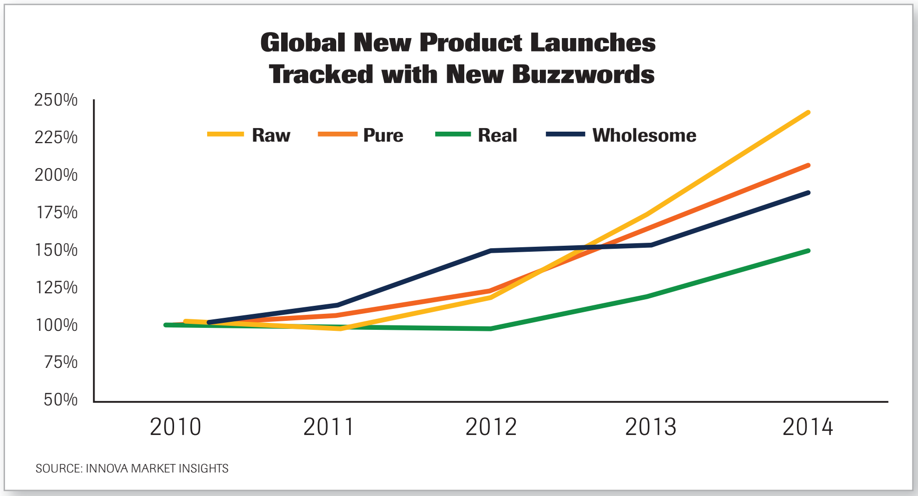
The world-class product development program at Global Food Forums, Inc.'s 2nd annual Clean Label Conference resulted in an attendance of well over 200. Shown here, the opening welcome.

Table of Contents

Clean Label: A Shifting Global Trend

According to Innova Market Insights, the "clean label" trend definition has officially shifted to "clear label." However, Innova's Head of Research, Lu Ann Williams, wonders if it has evolved even further. "Maybe it's 'clean conscience' or 'clear conscience.' It's about wanting to feel good about what we eat," she said during her presentation, "The Global Clean Label Phenomena: Trends, Insights & Implications."

Innova's latest data shows that consumers believe clean label means no preservatives (49%), no artificial flavors (47%), no artificial colors (39%) and no artificial sweeteners (35%). But this is only a narrow part of the consumer mindset, Williams said.



Consumers are demanding more clarity, in general. Looking around the globe, it's easy to see what's to come. As of April 2015, meat providers in Europe have to indicate the animal's country of rearing and slaughter. In Australia, there's a proposal to clear confusion on labels that would require a product with more than 50% imported ingredients to be labeled "made in Australia with mostly imported ingredients."

"This isn't happening here [in the U.S.] yet," Williams noted, "but it is coming."

Though not a new trend, brevity and understandability of ingredient labels are still paramount. A growing number of consumers find it important to recognize most of the names on ingredient lists, with Australia (71%), UK and France (68%), and China (65%) leading the charge, and the U.S. (37%) catching up.

In terms of verbiage, a few buzzwords in particular have made big gains in recent years. Innova tracked global new product launches (NPL) that used the terms "real," "wholesome," "pure" and "raw" from 2010-2014. Instances of "real" and "wholesome" have risen 52 and 88%, while "pure" and "raw" went up 106 and 141%, respectively.

"Naturally sweet" and "naturally occurring sugars" are growing, as well, with global NPLs in this arena increasing by 145% from 2010-2014. Examples include candy products using "real fruit" claims and soft drinks like Pepsi—which re-launched in June 2014 using prominent "made with real sugar" labels.

Similarly, the "superfood" label claim continues to grow, especially in cereals, where NPL instances saw 372% growth since 2009. A few other terms of interest are paleo, for unprocessed foods; and cold-pressed, for juices and veggie drinks. "Paleo" was mentioned five times more on NPLs in 2014 than 2013, and "cold-pressed" appeared four times as often in 2014 compared to 2010.

A growing number of consumers are interested in animal welfare and additives. More than half of Europeans reported the claims "GMO-free" and "grown without pesticides" as very important when they shop. Natural coloring is another area that's of increasing interest, and it will become a new standard, Williams said.

The penetration of all food products with natural colors has gone from 14.5% in 2010 to 17% in 2014 globally, while artificially colored products slid to just 3.9% in 2014. Preservative- and additive-free labels are likewise becoming an industry standard, Williams added, with many new products placing the claim on the front of the label. This is especially popular in baby foods and soups, as more than a third of them had "no additives/preservatives" claims on their labels in 2014 (39 and 33%, respectively).

"The rules are shifting, so it's a very interesting time—but also very challenging for the industry to adapt to changing consumer demands," she said.

Lu Ann Williams, Head of Research, Innova Market Insights, luann@innovami.com, +31.26.319.2000, innovadatabase.com

Defining a Trend, Then Regulating and Enforcing It

Catherine Adams Hutt, Ph.D., RD, CFS, Principal at RdR Solutions, and Chief Science & Regulatory Officer at Sloan Trends, sorted through the current state of various industry terminology in her presentation "Coming Clean: What Clean Label Means for Consumers and Industry."

Starting with "clean label," Adams Hutt stated simply that there currently is no regulatory or legal definition, nor are there enforcement concerns.

"The term is defined by the consumers and stakeholders," she said, citing retailers, like Whole Foods, Safeway, Trader Joe's and Kroger, which all have concrete definitions. Groups like

RiBran Food Ingredient

made in USA from California grown rice

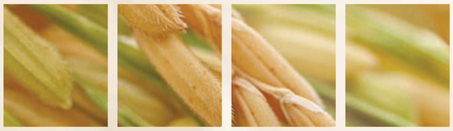
nutrient dense

- All Natural
- No Major Allergens
- Gluten Free
- Trans Fat Free
- Cholesterol Free
- Low Glycemic Index
- Non-GMO

riceBran technologies™

+1 888-757-7731
info@riceBrantech.com
www.riceBrantech.com

nutrition by nature®



Non-GMO Certification

"We'd like to think this issue will go away, because the science is clear that bioengineered ingredients are safe," says Catherine Adams Hutt, Ph.D.

"We've been eating genetically modified, bioengineered foods for more than 20 years. We know they aren't 'Frankenfoods,' but consumers aren't there with us." 52% of consumers say they know what GMOs are; 40% say they avoid GMOs in their daily diet; and 71% say it's because of concern for their personal health and well-being, according to recent Hartman data.

The original certifier of non-GMO foods, launched in 2009, is "The Non-GMO Verification Project," which has set detectable GMO limits to not exceed 0.9%, which is the European threshold. The Natural Food Certifiers launched "GMO Guard" in 2013, to complement their other certifications; it has a threshold of 0.05% GMOs.

From a regulatory standpoint, however, Adams Hutt said, "The FDA is not going to regulate GMO foods more than today. They've put their stake in the ground, and they've said definitively that foods resulting from biotechnology do not differ from other foods in any meaningful or material way, or present any difference or greater safety concerns than foods developed by traditional plant-breeding methods."

Yet, due to consumer concerns, various acts and bans have been passed or proposed in Vermont, Hawaii, Oregon and Colorado regarding GMO labeling. Also in response to consumers, several manufacturers have reformulated products with non-GMOs.

Clean Label Magazine and certain ingredient vendors have also offered definitions, including banned ingredients and processes.

There's likewise no regulatory definition for "natural," although the FDA has been clear in its expectation. FDA's website states, "It is difficult to define a food product that is 'natural,' because the food has probably been processed and is no longer the product of the earth." That said, the agency hasn't objected to the use of the term if the food contains no added color, artificial flavors or synthetic substances.

Conversely, USDA reviews meat and poultry labels with the term "natural" on virtually a daily basis, and approves or disapproves labels according to their labeling standards. The USDA issued industry guidance in 2013 by stating it allows "agricultural materials that are chemically changed due to allowed agricultural processing methods (e.g., cooking, baking, etc.)" to be classified as natural, but "heating or burning of non-biological matter to cause a chemical reaction" will be considered synthetic. It also states that natural foods cannot be transformed into a different substance via chemical change; altered into a form that doesn't occur in nature; or separated/isolated/extracted using synthetic materials.

The "natural" claim is the most controversial and has been enforced primarily through civil lawsuits. Companies have been sued by special interest groups and competitors for labeling products as "natural" when they contain ingredients including GMOs, erythritol, maltodextrin, HFCS, sodium benzoate, synthetic ascorbic acid and hydrogenated oils, among others.

Coloring and preservatives are worth noting, too, because—though they can be natural (e.g., beets, vinegar)—they aren't permitted in a "natural" labeled food product but are allowed in a "clean label" one. One approach to achieving natural status for a product that uses acidulants, for example, is to use the ingredient for flavoring, Adams Hutt said. Citric acid can be used to add flavor–and may have antimicrobial properties—but that is not the purpose for which it is used.

The slope gets even more slippery when comparing organic and clean label. The National Organic Program (NOP) allows the use of some compounds for "organic" foods that might not be considered to be "clean label," such as potassium bicarbonate, ammonium bicarbonate, calcium hydroxide and xanthan gum. Of the three terms, "organic" is the most clearly defined and regulated. The NOP heads that charge and doesn't permit bioengineered ingredients (GMOs).

"The simplest way to differentiate the terms," Adams Hutt noted, "is that 'organic' pertains to a food's origin, and 'natural' is what happens after it's grown or made."

A few ingredients have been blacklisted from ingredient lists simply due to "bad PR," in Adams Hutt's estimation. In the case of carrageenan, a researcher at the University of Illinois in 2008 claimed it degrades into toxic poligeenan, promotes inflammation and increases the risk of disease. These allegations have not been proven in humans, and the FDA officially rejected a petition in 2012—with the United Nation's Food and Agriculture Organization (FAO) and World Health Organization (WHO) likewise verifying the safety of carrageenan—but this doesn't stop the historical negative public communications.

Meanwhile, xanthan gum, which could be considered a "natural" ingredient due to its origin and processing, has been blacklisted by Whole Foods, Safeway and Kroger, simply because of its "chemical-resembling" moniker.

Catherine Adams Hutt, Ph.D., RD, CFS, RdR Solutions, cadams@rdrsol.com, 1-630-605-3022, and Chief Science and Regulatory Officer, Sloan Trends, www.sloantrends.com

Examples of Natural or Exempt Colors (21 CFR § 73)

Annatto extract	*Haematococcus* algae meal
Astaxanthin	Synthetic iron oxide
Dehydrated beets (beet powder)	Fruit juice
Untramarine blue	Vegetable juice
Canthaxanthin	Dried algae meal
Caramel	*Tagetes* (Aztec marigold) meal and extract
Beta-apo-8'-carotanal	Carrot oil
Beta-carotene	Corn endosperm oil
Cochineal extract; carmine	Paprika/oleoresin extract
Sodium, copper, chlorophyllin	*Phaffia* yeast
Toasted, partially defatted cooked cottonseed flour	Riboflavin
Ferrous gluconate	Saffron
Ferrous lactate	Titanium dioxide
Grape color extract	Turmeric/oleoresin
Grape skin extract (Enocianina)	

SOURCE: 2015 BURDOCK GROUP

Natural Color in the USA: What Product Developers Need to Know

Colors are added to food to make up for color losses during processing; to enhance naturally occurring colors; and to add color to foods that would otherwise be colorless or colored differently. Major food manufacturers, such as Nestle, are trying to create clean labels by removing FDA-certified colors so that they can declare "no artificial colors" on their labels.

FDA regulations make this a tricky proposition. Before 1958, the food industry used potentially dangerous ingredients as food colors. So the FDA created a set of food additive regulations for colors, which are contained in 21CFR, sections 73 and 74.

"All ingredients added for a coloring effect in food are considered color additives. However, colorful food additives, which are added for other functional benefits (such as flavor or texture) and do not change the original color of the food, are not regarded as color additives," said Ray Matulka, Ph.D., Director of Toxicology with the Burdock Group.

Colors are classified as either "certified" (synthetic) or "exempt from certification." Nine certified food colors were approved for use in the U.S. and require batch testing to ensure safety. The exempt colors are derived from natural sources, such as vegetables, animals or minerals. Generally, they have clean-sounding names; do not require batch testing; and are often times thought of as "natural."

U.S. color regulations may differ from those in other countries. For example, erythrosine is approved for use in the U.S. but only permitted for certain applications in the EU. Coloring agents are considered food ingredients in the EU, rather than color additives.

Titanium dioxide, although a natural color derived from ore, has a chemical-sounding name and has fallen into disfavor with some consumers. There were some concerns about the safety of caramel color, but the FDA evaluated it and determined there was no risk to consumers, said Matulka. In recent years, vegetarians and vegans have shied away from carmine, a coloring ingredient derived from insects, and the FDA now requires that it be specified on the label.

Sometimes coloring ingredients are created by mashing, cooking or concentrating vibrantly colored foods, such as purple sweet potatoes, elderberries and grapes. The color of these natural color ingredients can change or diminish, due to time or processing, and industry has developed innovative packaging and stabilizers to protect these colors.

Some natural colors, such as paprika and turmeric, can significantly impact food flavor. In the U.S., only colors that are listed in the CFR may legally be used in foods. However, fruit and vegetable juices, such as lime juice powder, can be used to impart color and do not require a color additive petition.

"Developing a color additive petition is no small task," explained Matulka. The petition should include the common or usual name of the ingredient; what's known about the source material; information about any toxic components that could come through the extraction process; and data on any heavy metals, solvent residues or pesticide residues. Stability data should be documented and reflect actual use and exposure. FD&C colors must always be listed on the food label. For natural colors, the color must also be listed, but the label might read "colored with beta carotene," "beet juice color" or an equally informative term.

Industry has moved away from using the term "natural." FDA considers all color additives as "artificial," even if they come from a natural source. Fortunately, the FDA is providing leeway in not using the term "artificial color," but there are limits.

Ray A. Matulka, Ph.D., Director of Toxicology, Burdock Group, www.burdockgroup.com, 1-407-802-1400

Fruit & Vegetable Ingredient Toolbox: Opportunities for Clean Labels

With a focus on clean labels, Marty Porter, Scientist at Merlin Development, discussed fruit- and vegetable-sourced ingredients functioning to sweeten, color, texturize, preserve, fortify and flavor. Highlights from sweeteners, colors and texturizers are as follows.

- **Sweeteners**—"Juice concentrates and purées have been sweetening options for a long time. Pear, apple and white grape are typically used due to their low flavor impact, but the sky is the limit," stated Porter. "A beautiful raspberry purée provides flavor, color and texture. Solids level must be considered when using these replacements."

Beet sugar is 100% genetically modified, after an industry-wide decision in 2008, but evaporated cane sugar can be a non-GMO source of sucrose. Vegetable sources, such as sweet potato and carrot juice, are also used, but sugar profile and chain length [of polysaccharides] are considerations when replacing the current sweetener. Also note that disaccharides are less efficient at controlling water activity than monosaccharides.

• **Colors**—Chemistry comes into play here. Carotenoids are lipophilic, so generally they need to be emulsified in aqueous formulas. They are heat-stable but lose color through oxidation. Anthocyanins are water-soluble but are also heat-, pH- and oxygen-sensitive. Product pH impacts their color. Betacyanans are stable between pH 4-7, but heat-labile. "Any baker who's tried to make a red velvet cake with beet powder [betacyanins] knows it turns brown," added Porter.

Chlorophylls are soluble in polar solvents and are heat- and light-sensitive. Caramel colors can now be sourced from caramelized onions, garlic, pear and apple. The shade of brown and flavor depends, in part, on source material. "Label simplifications result if an ingredient is used for both color and flavor; a win-win," she added. To preserve color, Porter recommended waiting to add color until later in the process, if possible, and using packaging solutions.

Comparisons can help choose sweetener systems. HFCS is a fairly high solids product, therefore a good replacement might be tapioca syrup or agave nectar, which match that pretty well. The sugar profiles are different for a lot of these, so if replacing HFCS, for example, fructose and glucose need to be replaced.

• **Texturizers**—Fruits and vegetables contain cellulose and lignin in their cell walls. These components can be used to provide texture to a food system. Refined fruit fibers have shown moderate success as modified starch replacers. Native root starches, like tapioca, potato and arrowroot; and purées of sweet potato and pumpkin, are all popular texturizers in clean label formulas. One consideration is a lower level of viscosity standardization.

"Pectin from apple and citrus is well-known but requires pH and solids to gel, unless chemically modified—not in the spirit of clean labeling," Porter said.

Legume flours offer functional proteins and carbohydrates that can deliver various textures. "Cooked chickpea flour provides immediate viscosity in water, while the uncooked flour does not. Therefore, ratios of the two can be used to create the viscosity desired," advised Porter. Whole-fruit pieces can deliver texture in granola bars and meat analogs. Xanthan and guar gums are still seen in Whole Foods markets; they are useful tools that should not be ruled out.

• **Preservatives/Antimicrobials**—Making food safe is a primary task of food developers. Organic acids, like sorbic and benzoic, have been widely used in the past. Those same acids are contained in some fruits. Citrus, pomegranate or plum derivatives have high levels of organic acids, but there is no fruit extract commercially available for

Liquid Sweetener Composition

Source	% Total Sugars/Solids	% Fructose	% Glucose	% Maltose	% Sucrose	% Sorbitol	% Higher DP
Corn syrup 42/43	81	0	19	14	0	0	67
Brown rice syrup 42/43	77		3	45			50
HFCS 42%	71	42	52				6
HFCS 55%	80	55	41				4
Tapioca syrup - 28 DE	79	0	3	13			54
Agave nectar - 76 BRIX	78	71	25				4
Apple juice conc – 70 BRIX	66	58	27		13		
Pear juice conc – 70 BRIX	52	53	11		15	21	
Raisin juice concentrate	69	53	47				
Prune juice	20	26	52		22	0	
Sweet potato juice - 60-62 BRIX	43	9	65	5	19	0	2

SOURCE: MERLIN DEVELOPMENT

antimicrobial use. Bakers have long used raisins for their anti-mold effects. Raisin and prune juice concentrates contain propionic acid, but their water activity, pH and phenolics also contribute to preservation. Nitrites derived from celery, beets, carrots and spinach juices are effective in meats.

Higher usage levels are necessary, though they add higher costs; however, combining ingredients can result in synergies. Porter suggests trying multiple acids at low levels, so no characterizing flavors result.

In summary, whole-fruit solutions are recommended, if possible, because flavor, color, texture and nutrition arrive in one ingredient, said Porter.

Martha (Marty) Porter, Scientist, Merlin Development, Inc., mporter@merlindev.com, 1-763-475-0224, www.merlindevelopment.com

Antioxidant Potential of Plant-based Food Ingredients

Antioxidants are a group of molecules, abundant in plant foods, with unique chemical structures that allow them to scavenge free radicals. Although antioxidants have been used in the food industry since the 1800s, their popularity soared around 2000, as scientists began to understand the role of free radicals in creating oxidative stress and how that stress acerbated chronic diseases, including inflammation and cancer, and age-related chronic disorders.

"Antioxidants have two primary uses in foods—extending shelflife by preserving food; and enhancing nutritional value and health benefits," explained Jin Ji, Ph.D., Chief Technology Officer & Executive Vice President at Brunswick Laboratories, Inc. Both exogenous forces, such as heat and light, and endogenous components, such as transitional metals, contribute to the process of oxidation.

Natural antioxidants have a long history of use in North America, dating back to Native Americans. In 1920, the antioxidant industry emerged and initially focused on synthetic antioxidants, such as BHA and BHT. In the 1980s, the trend shifted to natural antioxidants.

Antioxidants fall into several major groups. The first is phenolic compounds, which are found mostly in seeds, berries, herbs and spices. The second group is tocopherols, which are isomers of vitamin E and occur primarily in nuts, seeds and vegetable oils. Other sources include ascorbic acid, citric acid and carotenoids.

"A food formulator needs to first quantify the antioxidant level. Brunswick Laboratories provides ORAC assay, or Oxygen Radical Absorption Capacity, a quick and cost-effective method to quantify antioxidants," added Ji.

Using test methods that are accurate and repeatable, the industry has developed robust databases that enable food formulators to select an optimal antioxidant ingredient based on ORAC values. Industry has also developed quick, industry-specific methods to quantify specific antioxidant sub-groups, such as phenolic compounds and anthocyanins. When an even more targeted approach is needed, labs can "fingerprint" specific antioxidant constituents.

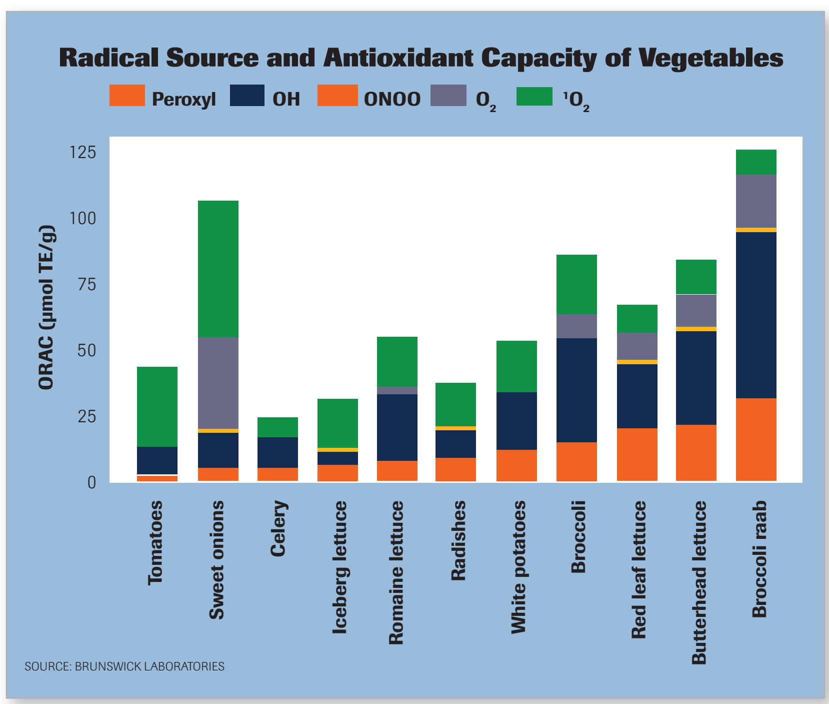
An ORAC database was first introduced by the USDA in 2007, with the initial release containing data on 277 food items. After widespread misinterpretation by consumers, the USDA withdrew the database from their website in 2012. ORAC values are expressed as µmol of Trolox Equivalents (TE). In order for the data to be properly interpreted, one must note whether the TE values are per 100g or per serving.

Spices generally have high ORAC values, as do cocoa and pomegranate. The original ORAC assay only measures antioxidant capability of a material against only one free radical—peroxyl—when in fact many foods contain multiple free radicals, noted Ji.

A newer measure, ORAC 5.0, evaluates against all five primary radicals. (See chart "Radical Source and Antioxidant Capacity of Vegetables.") Both ORAC and ORAC 5.0 values are available on the Brunswick Laboratories website at www.brunswicklabs.com/tech-library/orac-database.

Food formulators need to know how a specific antioxidant ingredient will perform in their food system. Important questions to

The original ORAC assay only measures antioxidant capability of a material against the peroxyl free radical. ORAC 5.0 adds four additional free radical values to that of peroxyl, which results in a higher ORAC value that does not always correlate with the traditional ORAC value.



explore include availability, cost-effectiveness, stability and compatibility with the other components of the food. Another consideration is whether to choose a synthetic or a natural antioxidant.

Antioxidants have potential to promote mental sharpness and heart health; and to reduce cancer, inflammation and vision problems. Label claims can be supported through preclinical studies and, ultimately, clinical trials.

Ji reminds food formulators that in the competitive food market, "Science-backed products will win."

Jin Ji, Ph.D., Chief Technology Officer & Executive Vice President, Brunswick Laboratories, Inc., http://www.brunswicklabs.com/, 1-508-281-6660, blservices@brunswicklabs.com

Clean Label Antimicrobials: How to Find Them?

There is a market demand for fresh products with extended shelflife. TNO, the Netherlands-based company, has made a commitment to identify and isolate antimicrobial compounds from a variety of sources as part of their commitment to help find "clean label" alternatives for the food processing industry, said Frank Schuren, Ph.D., Senior Scientist Microbiology, TNO Microbiology & Systems Biology.

It is well-known that many herbs and spices have antimicrobial activity. However, research on these properties is lacking, and, where it has been done, the research tends to focus on food pathogens—not spoilage organisms, such as yeasts and molds.

TNO has conducted screening studies that have not only looked at the antimicrobial properties of a wide range of spices, but looked at variables essential to their functionality in food systems, such as the effects of pH and concentration. Schuren noted that antimicrobial compounds that adversely affect desirable qualities, such as flavor, aroma or color, simply would not be accepted in the marketplace.

The challenge is not only to determine which spices and herbs have antimicrobial properties, but to look at how they perform in food systems alone or in combination with other products. The objective is to find synergies and interactions of compounds that will provide significant inhibitory effects, while having less impact on a food's sensory quality.

This has spurred the investigation of novel approaches to locate effective, usable antimicrobials from nature. One tool adopted by TNO is the use of bacterial cells as a biosensor and, thus, as a predictive tool. The company has established that gene expression in cells correlates with external stress factors, like temperature and pH. It has used this to better understand cell behavior in food processing environments.

The research process employed first identifies model spoilage strains, then sequences a strain's genome. Analytical tools, such as microarrays and next-generation sequencing, are then used to assess specific stress responses. This helps to identify biomarkers that can be used in screening approaches to look for ingredients with desired effects. For example, model spoilage strains may then be exposed to different herbs and spices, or their extracts, to clearly identify microbial activity incorporating variables such as acidity and concentration.

One application is to look at different spoilage organisms in the food processing environment and evaluate how these might be controlled. Utilizing environmental sampling techniques, such as air sampling, and subjecting these samples to taxonomic profiling of the microbial communities, TNO has identified the different organisms found in such environments, Schuren reported. By sequencing isolates, they have the capability of identifying bacterial flora, fungi, eukaryotes and other organisms.

Up to 20 million sequences and more than 400 samples may be evaluated in a single run. Understanding the microbial flora in an environment allows the implementation of targeted solutions that are sustainable. It also provides users with the ability to reduce dependence on chemicals traditionally used for cleaning and sanitizing.

Another function is to expand the application of microbial fermentations. Fermentation has been an integral part of food preservation for thousands of years and is responsible for commercial products, such as wine, beer, cheese, bread and many others. The goal is to take these processes further and utilize fermentation technologies to produce more foods that taste good but can be marketed with a clean label.

Frank Schuren, Ph.D., Senior Scientist Microbiology, TNO Microbiology & Systems Biology, Frank.Schuren@tno.nl

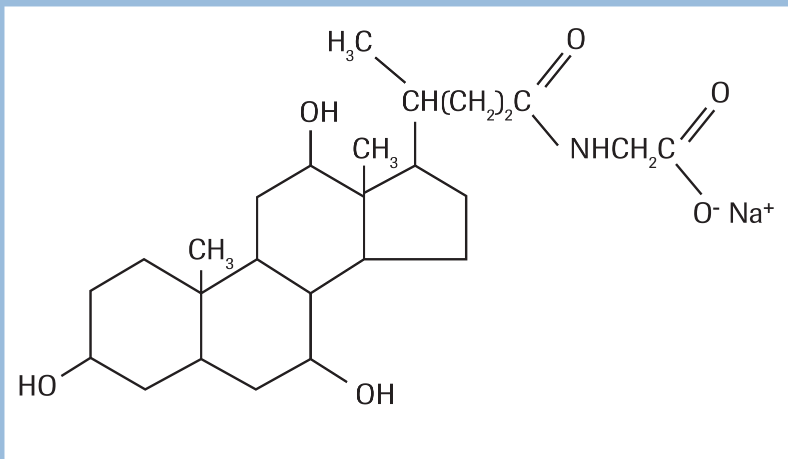
Answering the Challenge: Label-friendly Emulsifiers and Surfactants

Researchers have explored a wide variety of natural, clean label emulsifiers and surfactants.

"Unfortunately, industry faces significant hurdles to commercialization for some of these products. Current natural emulsifiers will probably never match traditional emulsifiers for performance, and some novel emulsifiers may be clean label but may not be appealing to consumers," said Professor Peter J. Wilde, Ph.D., Institute of Food Research.

All emulsifiers contain a hydrophobic or fatty acid component which likes the oil phase, and a hydrophilic or polar head which

Sodium glycocholate (a bile salt)



Bile salts, which are currently found in dietary supplements, are excellent emulsifiers and may have potential for food use.

likes the water phase. Emulsifiers are ranked on an HLB scale from 1-20. A rating of 1 is given to a very oil-soluble or hydrophobic emulsifier, while a rating of 20 indicates a very water-soluble or hydrophilic emulsifier. Traditional natural food emulsifiers include egg yolk and soy lecithin, both rich in phospholipids.

Synthetic emulsifiers include mono- and diglycerides, which are derived from naturally occurring fatty acids that have been processed to control HLB and functionality, and also esters of monoglycerides. Polysorbates and sucrose esters are synthetic ingredients with a large polar head group, making them very effective surfactants, said Wilde.

Food products where emulsification is important include mayonnaise, margarine, chocolate, bread, meats, ice cream and whipping cream. Wilde gave numerous examples of potential natural emulsifiers and surfactants.

- **Quillaja extract,** derived from the bark of the soapbark, is rich in saponin, a natural surfactant.
- **Bile salts,** typically derived from ox bile and sold as dietary supplements, show potential as food emulsifiers.
- **Lipoproteins** are natural oil bodies in plants and animal tissues, such as egg yolk, soy or sunflower. When concentrated, they create highly stable and energy-efficient emulsifiers.
- **Chloroplasts** are plant membranes that are packed with galactolipids. These are good emulsifiers; can inhibit fat digestion; and have been linked with foam stability in bread. Unfortunately, they are difficult to process.
- **Hydrophobins** are secreted by filamentous fungi and form a strong film on the surface of a bubble. They can provide excellent long-term stability of bubbles in ice cream and are responsible for gushing in beer.
- **Cuckoospit froth,** an incredibly stable foam secreted by froghopper insects, is a natural glycoprotein, but is not necessarily label-friendly.
- **Tannins** derived from grape seed and apple show emulsifying and antioxidant properties.
- **Lactic acid bacteria,** such as *Lactobacillus pentosus*, produce efficient biosurfactants and bioemulsifiers.
- **Dairy proteins,** including both whey protein and casein protein, contain hydrophobic and hydrophilic groups. They form an elastic interface and find use as whipping agents.
- **Hydrophobins** are a group of proteins that can create elastic interfaces which improve mouthfeel in low-fat products and create the sensory perception of a higher-fat product.
- **Natural carbohydrates,** such as gum Arabic and sugar beet pectin, have both protein and carbohydrate components and are popular for stabilizing flavor oils.
- **Small starch granules,** such as quinoa and rice, can be modified to form stable emulsions. These rely on a process called Pickering stabilization to create stable droplets.

There is significant potential in process modification, enzymes and bacteria to alter the functionality of some clean label alternatives. One approach is to modify the natural molecules that already exist in the food. For example, lipid bodies in pumpkin seed are already in emulsified form, and industry is looking at ways to exploit these oil bodies in situ. Another approach is to use processing aids, such as lipases which alter the lipid profile of natural grains, thus improving crumb structure in baked products. Many of these novel ingredients and approaches show strong promise for commercialization.

Peter Wilde, Ph.D., Institute for Food Research, www.ifr.ac.uk, peter.wilde@ifr.ac.uk, +44 (0) 1603 255 000

Back to the Future in Baking: Clean Label Bakery Formulations

When it comes to formulating clean label baked goods, what's old really is new again, said David Busken, Manager of R&D, Oak State Products, Inc. In preparation for his talk, Busken reviewed bakery formulations dating back decades and marveled at how "clean" those formulations were as recently as 30-40 years ago.

So, if the bakers of yesteryear could create breads, cakes and cookies using a relatively label-friendly toolkit, it stands to reason that today's bakers could do the same.

Acknowledging that the precise outlines of a "clean" bakery ingredient remain fuzzy, Busken cut to the chase by sharing his own definition—it has a familiar name; it's undergone minimal processing—and noting that many traditional bakery staples not only fit this bill but provide essential functionality, besides. The trick, he said, lies in understanding which ingredients are available, knowing where to find them and figuring out how to use them.

As a case in point, he relayed an anecdote from the 1940s. Yeast-raised donuts were notorious for drying out within hours of production. At some point, someone had the insight to mix mashed potatoes into the dough, hoping that the moist-and-fluffy side dish might improve the donuts' texture. It both extended their shelflife from hours to days and "made an industry," Busken said.

Finding clean label solutions is easier when building a baked good from scratch, Busken said. Cleaning up existing formulations is by far the heavier lift, if for no other reason than consumers' established expectations for taste, texture and shelflife. (And don't disregard the implications reformulation might have on production, packaging, supply chains and more; if a clean label cookie spreads more than its predecessor, for example, it may not fit into its tray, Busken pointed out.)

He walked the audience through several examples of how pre-existing ingredients, not to mention strategic tweaks to processing and handling, can combine to form clean label baked goods as hedonically appealing as they are operationally friendly. Here are just a few of the cases he discussed:

- **High-ratio layer cakes.** Such cakes—named for their high ratio of sugar to flour—are among the more challenging bakery products to "clean," because they depend on emulsifiers and chlorine-bleached flour for their fine grain and softness, Busken said. His clean-up suggestions: Use a heat-treated flour instead of a bleached one; replace "chemical-sounding" emulsifiers, like PGME (propylene glycol and mono-esters) with cleaner options, like mono- and diglycerides (although not all may consider these two an option) and lecithin; and adjust the sugar-to-flour ratio downward—say, to 115-120%.
- **Muffins, quick breads and Bundt cakes.** Because these products are usually 35% oil, 30% whole egg and 20% water, Busken said, they tend to remain moist on their own. But emulsifiers like sorbitan monostearate still often show up to produce a finer grain, moister texture and longer shelflife. Here again, hydrated mono- and diglycerides and lecithin can achieve similar results without dirtying up a label. What's more, Busken added, "I've done quite a bit of work on this; just get your sugar and flour ratio right and you can do that from scratch fairly easily."

By approaching formulation with a sense of openness and ingenuity, contemporary bakers can find clean label solutions, such as the savvy adjustment of sugar and flour ratios, or utilizing coconut oil's capacity to improve the eating quality of cookies that would otherwise lean on trans fats.

- **Brownies and bars.** Chewy brownies and bars often rely on emulsifiers for their characteristic moistness. But Busken said that by simply manipulating both the levels and types of sugars and fats in the formulation, "you can get any kind of brownie you want with any kind of shelflife." He pointed out that fats lower in saturates will produce the right density, while noting that the key with sweetener choice is controlling how quickly the sugars crystallize, as well as how quickly the starch structure recrystallizes.
- **Crisp and soft cookies.** Making a clean label, crisp cookie is a snap, but keeping a cookie soft for a six-to eight-month shelflife without using "chemicals" takes more effort. Once more, "crystallization control is your ally." Syrups made from oats, tapioca, brown rice and agave have risen to the challenge, as have the sugars fructose, maltose and invert brown sugar, Busken said. And, to hold onto water in the finished product, he advised looking into label-friendly gums and hydrocolloids.

By paying attention to fermentation times and temperatures, the heat source in the oven or even how much agitation a pan of rolls receives as it proofs, bakers can create products with simpler, more familiar ingredients. It might sound old-fashioned, but in a clean label environment, that's downright cutting edge.

David Busken, Manager of R&D, Oak State Products, Inc., david.busken@oakstate.com, 1-815-853-4348, www.oakstate.com

PROCESSING PANEL, Speaker 1: Processing Technologies and Their Central Role in Clean Label Products

Meeting the demands of an ever-changing marketplace, which includes Millennial moms among many other groups, is a challenge for food processers. Food processors must do market research to anticipate trends and directions, so they can introduce products in a timely manner. Meeting consumer trends can create demands with which R&D and plant personnel often struggle, since they may be technically infeasible, said Jeffrey Andrews, Sr. Director of Contract Manufacturing, HP Hood, presenting “Technology: The Core Ingredient in Natural Foods” for a panel on processing advances relevant for clean label products.

Technology is one of the best tools food processors have in their arsenal to meet these demands, especially technologies that help produce foods that have clean labels and/or appear fresher. When one steps back and looks at how the food industry has grown, there is a direct correlation between the development and implementation of new technologies and getting new and more desirable products to market.

There is a broad range of such technologies. They include filtration technologies; thermal processing technologies, especially high-temperature, short-time or agitating processes that produce minimal changes in flavor and texture; high-pressure processing which may be used for processing high-value products without altering characteristics; in-package technologies for pasteurization or sterilization; and packaging technologies employing new materials and/or modified atmospheres.

In meeting the marketing department’s demands, packaging is the most visible—but also one of the most impactful—for delivering clean label products that are commercially viable. I-beam film skeletons allow film properties to be modified through the insertion of components that expand the capabilities of the package. They allow for better control of moisture-vapor transmission, enhanced vitamin retention and the adoption of a lighter overall package.

Processors can also better manage oxygen in packages through gas flushes, utilization of modified-atmosphere packaging, pulling a vacuum or the addition of oxygen scavengers. If a decision is made to use any of the oxygen technologies, such as vacuum or modified atmospheres, processors also need to adopt packaging that best showcases the technologies.

Millennial moms are demanding consumers with a strong interest in clean label products. Oddly, in order to meet their demand for simple, fresh food, the food processors must turn to the technologist to make it happen.

Jeffrey Andrews, Sr. Director, Contracting Manufacturing, HP Hood, Jeffrey.Andrews@hphood.com, 1-617-887-8440, www.hphoodllc.com

PROCESSING PANEL, Speaker 2: High-pressure Processing: Opportunities and Challenges

High-pressure processing is an old technology that has become economically feasible through advances in engineering. Indeed, it is estimated that the cost of this processing technology has been reduced thousands of times over the last 100 years.

There are a number advantages to foods offered by the technology, noted Kathiravan Krishnamurthy Ph.D., Assistant Professor of Food Science and Nutrition, Illinois Institute of Technology, as the second speaker on the clean label processing panel.

These benefits include:

- Extended shelflife and improved food safety
- Pressure inactivates yeast, molds, bacterial cells and most viruses
- Minimal change in food flavor, color, texture, nutritional value, providing fresh-like characteristics
- Improved food quality
- Fewer/no additives, which helps answer demands for clean labels
- Can alter products high in protein/starch and produce novel food products

In high-pressure processing, the pressure is transmitted uniformly throughout the product. The product is not crushed, yet vegetative cells of both spoilage and pathogenic microorganisms are inactivated. It will also inactivate viruses and denature some enzymes. Because high-pressure processing will not destroy spores, high-acid or acidified products may be more safely processed. They must also be refrigerated to protect quality.

In addition, most products that are now being processed using this technology are high-value items, such as guacamole, oysters and ready-to-eat (RTE) meats. Oysters have been a real success story. High-pressure processing has been shown to inactivate viruses, extend shelflife, increase the yield of meat and minimize the labor involved in shucking.

One challenge with RTE meats has been the potential for *Listeria monocytogenes* contamination following processing. High-pressure processing of packaged RTE meats eliminates this concern and extends shelflife.

Applying this technology to juices and other agricultural commodities has been shown to enhance shelflife, provide a fresh-tasting product and enhance product safety with minimal adverse effects on nutritional content. However, any processor wishing to adopt the technology as a means for ensuring food safety has another challenge. They must validate that the process will deliver a minimum of a 5-log reduction (99.999%) to the target pathogen or a non-pathogenic surrogate which has been shown to have similar resistance as the target organism.

There are a number of potential opportunities for high-pressure processing. These include extended shelflife yogurts, fresh fruit and yogurt products; cheeses that have the flavor of raw milk cheeses or those with improved texture; products in which post-packaging microbial contamination may be removed, such the RTE meat example cited earlier; and enhancing functional properties of different products and ingredients, such as those with bioactive properties.

High-pressure processing is one of the few novel, non-thermal processes that has become commercially viable. Combining high-pressure processing and heat (pressure-assisted thermal sterilization) can be used for producing shelf-stable foods by inactivating spores. Processors wishing to adopt high-pressure processing need to do their homework beforehand and closely examine the pros and cons of the technology, including equipment costs.

Kathiravan Krishnamurthy, Ph.D., Assistant Professor of Food Science and Nutrition, Illinois Institute of Technology, kkrishn2@iit.edu, www.iit.edu/ifsh

Global Food Forums, Inc. wishes to thank the speakers, attendees, sponsors and tabletop exhibitors for making the 2015 Clean Label Conference a very successful event. Complimentary copies of the presentations maybe downloaded from http://globalfoodforums.com/2015-clean-label/store. If anyone is interested in receiving future notifications of when complimentary conference special reports and presentations become available, please sign up at http://ow.ly/OsEtm.

Global Food Forums, Inc. wishes to thank the following sponsors of this report:

At SunOpta, we add value to our non-GMO and organic raw materials to produce high-quality ingredients for formulating natural and clean label food products. Our technical and applications experts work with customers on customizing on-trend formulations, and natural processing techniques differentiate us in the ingredient industry. Included in the portfolio is our family of insoluble non-GMO fibers, organic grain-based ingredients, natural fruit preparations, functional starches and custom ingredient manufacturing. Visit us to learn more at www.sunopta.com.

IOI Loders Croklaan

An established leader in trans-free oil ingredients, IOI Loders Croklaan delivers a reliable supply of PHO-free oils and shortenings, and works alongside food manufacturers in the reformulation and creation of applications. Through sustainable, non-GMO ingredients and R&D expertise, we help to eliminate trans fats and deliver exceptional sensory qualities in a variety of applications. Call (844) GO-NO-PHO and make the trans-free transition, easily.
http://northamerica.croklaan.com

RiceBran Technologies (NASDAQ: RIBT and RIBTW), is a global leader in the production and marketing of value-added ingredients derived from stabilized rice bran. RIBT has proprietary and patented intellectual property that enables the conversion of rice bran, one of the world's most underutilized food sources, into a number of highly nutritious human food ingredients, which are vegan, non-GMO-verified, gluten-free and make whole grain rice and brown rice flour packaging claims possible.
www.ricebrantech.com

Jenny Bogdajewicz, Conference Coordinator

Barbara T. Nessinger, Content Manager

Trevor Kupfer, Contributing Editor

Peter Havens and Claudia O'Donnell, Co-owners

Peter O'Donnell, Cover Design

Global Food Forums, Inc.

www.GlobalFoodForums.com

P.O. Box 1421

Saint Charles, Ill., USA, 60174

+1.800.799.9671