FOOD PRODUCT DESIGN®

TARGETING TEXTURE

March 19, 2012

By Donna Berry, Contributing Editor

Less than a century old, the discipline of sensory science continues to evolve as researchers gain a better understanding of how our five senses—hearing, sight, smell, taste and touch—impact our decision to like or dislike a food. Most notably, in the past couple of years, ingredient suppliers have aggressively pursued the areas of texture and mouthfeel, attributes that can get confusing at times, as they are independent functions that sometimes work together synergistically … but not always.

“Texture is the overall experience of how a substance feels, from stirring it with a spoon to spreading it on a cookie, clinging to a chip, crunching when you bite, coating your mouth, etc.," says Laura Quinn, application specialist, DuPont Nutrition & Health, New Century, KS. “Mouthfeel is specifically what is experienced when the food is in your mouth, including the effect, if any, after swallowing."

Additional textural attributes include how a product looks or adheres to its container, and how it pours, as with a beverage, according to Matt Patrick, vice president of R&D, TIC Gums, White Marsh, MD.

“Texture contributes to the overall eating experience and can impact flavor release of a food product," adds Suzanne Mutz-Darwell, senior market development manager, texture, Corn Products/National Starch, Bridgewater, NJ. "While consumers often have a hard time describing texture and articulating what is a good or bad texture, they know when they like or don’t like something." What constitutes an acceptable texture differs from person to person, from application to application.

Building on these descriptions, Steve Smith, R&D manager, Penford Food Ingredients, Centennial, CO, says: “The texture of a food product is a collection of sensory attributes. It is how a person perceives a food product through visual, auditory and physical senses."

These are reasons why texture is one of the most complicated attributes for formulators to understand and why, historically, they have shied away from addressing texture in the early stages of product development. But understanding and addressing texture up front saves time later in the development process, when a formulator must go back and fix the crunch, improve the adhesion or modify the spread.

MaryAnne Drake, professor and director, e Sensory Analysis Center, North Carolina State University, Raleigh, co-funded by the Dairy Research Institute, Rosemont, IL, confirms that texture is a multi-modal (perceived by several senses) sensory perception of structural, mechanical and surface properties. Mouthfeel refers to the oral-tactile qualities perceived in the mouth, including but not limited to, astringency, viscosity, slipperiness and mouthcoating, she explains.

“The most critical issue is that both of these terms—texture and mouthfeel—are sensory terms," says Drake. “This means they are perceived, and therefore measured, by humans, not machines. The problem is that formulators generally think of these attributes in terms of mechanical and rheological properties. In some cases, texture and mouthfeel relate to these properties, but there are many aspects of texture and mouthfeel that do not directly relate to an instrumental measurement. If you don’t have sensory measurements, you are only measuring physical properties."

This is similar to how the industry understands and communicates flavors. “If you don’t have human sensory perception when characterizing flavors, you are only measuring volatiles, not what the consumer actually tastes," Drake adds.

This makes human sensory panels, including a universally approved language, or lexicon, necessary when considering texture in the product development process. The lexicon is a powerful way of articulating texture to help formulators plan and describe the attributes that can provide finished food products with improved consumer acceptance.

“While texture is one of the most basic attributes of food sensory experiences, it has traditionally been an under-leveraged aspect of food product formulation," says Patrick. "With no commonly accepted language for discussing it, descriptions of texture have been quite vague."

In response, a number of suppliers of texturants, which include carbohydrate, fat and protein suppliers, as well as suppliers of mouthfeel flavors, have developed a systematic approach to identifying, describing and formulating desired textural effects in foods and drinks.

The industry now has a robust, globally relevant language to help product developers elevate texture to the equal of flavor in the formulation process," says Joseph Light, vice president of global development, Corn Products/National Starch. “By translating what consumers like and dislike about food texture into precise sensory attributes whose intensity we can measure, we can make direct, rapid connection to a texture solution to support what we know will be an appealing finished product."

Helen Simpson, sensory manager, Corn Products/National Starch, adds: “This language helps people understand the building blocks of a consumer-preferred texture in a range of applications. We now know that what a consumer calls ‘creamy’ is actually a multi-faceted texture experience that results from differing intensities of at least 15 sensory and rheology attributes, such as mouth coating, meltaway and oral viscosity. Understanding this gives us the ability to characterize various products by the specific, precise attributes that constitutes a creamy experience in a product such as yogurt, and plot them on a texture map. Our texture maps position commercial products on a map with texture attributes as the directional markers so we can easily see the texture similarities and differences. From there we can help our customers target and achieve the luscious creaminess consumers want."

Ingredients that impart texture

When targeting a bull's-eye for texture, formulators typically try to work with as few ingredients as possible to keep labels clean.

“Having a texture language not only reduces product development times by taking the guesswork out of texturant selection, it also helps with keeping formulations clean and simple. This often translates to cost savings and an improved bottom line," says Patrick. “When better texture is addressed earlier in the development process, it is possible to improve the way flavor is delivered and perceived."

At the SupplySide West International Trade Show and Conference in October 2011, TIC Gums showed attendees how texturants can assist with improving the texture of diet beverages. The company sampled a number of iced teas with varying texture to illustrate the difference texture can make in enjoyment and preference of the drinking experience.

“While these were only tea samples, the same results are available for food scientists and developers who can positively manipulate eating and drinking experiences for their customers by adjusting the texture and stabilization modifiers included in all consumables, not just tea," says Patrick.

When sugar is removed from beverages, such as tea, and replaced with high-intensity sweeteners, the sweetness gets replaced, but the mouthfeel that accompanies dissolved sugar or corn syrup does not. “The viscosity that sugar delivers is not replaced with high-intensity sweeteners," Patrick says. “Without the addition of texture modifiers, such as the blend of gums we identified for a diet iced-tea application, sugar-free drinks seem thin and lack body. Lower viscosity also has the liquid clearing the palate very quickly, with little flavor remaining in the mouth or on the tongue during or after swallowing."

Ross Clark, distinguished research scientist, CP Kelco, San Diego, adds, “We’ve conducted some studies that show it is not just the viscosity of sugar that provides body to beverages, but it is also the presence of various flavor sensations, including metallic, dryness or astringency in the sugar-free beverage that contributes to its lack of body and mouthfeel."

Indeed, ingredient suppliers recognize the secret to delivering a great taste experience in sugar-free or sugar-reduced beverages is to optimize the balance between texture, sweetness and flavor. “We use a blend of texturizers, sweeteners and flavors to balance taste and mouthfeel with unmatched precision," says Bill Gilbert, principle food technologist, texturizing solutions, Cargill, Inc., Minneapolis. Using “tribology"—the science and technology of interacting surfaces in relative motion—the company is able to more accurately mimic and measure what goes on inside the mouth when a beverage is consumed.

“The new approach helps customers save time and reduce costs," adds Wendy Erickson, technical service manager, Cargill. “The texturants are designed to optimize mouthfeel while also possibly allowing beverage makers to use less sweeteners or other ingredients to achieve the same mouthfeel."

Hydrocolloid contributions

Formulators typically turn to hydrocolloids first when trying to manipulate texture. It’s important to remember that hydrocolloids vary significantly in their performance, price, ease of use and even impact on clean labeling.

“Each type of hydrocolloid has different flow behavior," says Kathleen Deely, marketing manager, North America, CP Kelco. “There are some that are pseudoplastic, some are Newtonian, or those that form gel-like networks at rest but flow readily when pouring. These are suspension matrices and are best suited for assuring uniform delivery of vitamins and minerals or helping prevent overall separation."

Quinn explains that xanthan gum, carboxymethyl cellulose (CMC), microcrystalline cellulose (MCC), locust bean gum and guar gum are primarily used for thickening, while alginate, pectin and carrageenan are usually used for gelling. “Xanthan gum is very effective at particle suspension and provides very good cling. In addition to viscosity and mouthfeel, locust bean gum and guar gum provide good syneresis control," she says. “CMC is also a good viscosifier at low dosages and dissolves fast in hot and cold water.

“In addition to thickening, MCC can provide foam stability and has good suspension qualities," adds Quinn. “Alginate is one of the cold-soluble hydrocolloids. It gels in the presence of calcium. Carrageenan is also ionic and can form gels in the presence of calcium and potassium, depending on the type of carrageenan. Pectin has many functions, including gelation, protein stabilization, suspension and viscosifying."

Best blending practices

Often, a blend of texturants is necessary to hit the target texture and mouthfeel. “Usually, the formulator has an ideal texture in mind that requires translation for proper blending of ingredients," says Janae Kuc, senior research and development scientist, Gum Technology Corp., Tucson, AZ. “Our approach is to get ample information on the ideal end product. In many cases it is important to retain information on other stabilizing systems in the product, as well as any ingredients that may have a synergistic reaction with the texturants."

For example, “in a whipped mousse, a combination of starch and gum typically outperforms a starch system alone, which will only provide viscosity," says Kuc. “The texture of a combined gum and starch system may be lighter and airier while providing a cleaner, smoother flavor release. Synergistic reactions of starches with gums often provide more appealing textures to consumers."

With some applications, texture is all about mouthfeel. “We have a new blend of hydrocolloids that adds viscosity and improves mouth coating in low-fat chocolate milk," Patrick says. “The ingredient system creates a beverage that remains in the consumers’ mouth, literally painting the palate with chocolate flavor."

Kuc builds on the example of nonfat chocolate milk, a product formulators are aggressively trying to make taste like the full-fat product in order to keep kids drinking it in the schools. “A good example of a favorable mouthfeel is the fatty, creamy texture one experiences in a high-fat chocolate-milk beverage, as compared to a lowfat or nonfat chocolate-milk beverage," she says. “Gums come into play to increase the fatty mouthfeel and provide a sensory

perception that is comparable to a full-fat product. For viscosity building and texture enhancement we suggest a blend of xanthan gum and carrageenan.

“A major hurdle we address constantly is the texture difference between gluten-free bread and bread containing gluten," continues Kuc. “The texture of bread stems from the gluten bonds that trap air and carbon dioxide during the baking process to create the cell structure of bread. In gluten-free systems, we have to recreate the texture. This is usually achieved by a synergistic reaction between gums, such as tara gum, konjac and cellulose gum, which increases the viscosity of the bread dough to mimic some of the air-trapping capabilities."

Smith says: “We have found that blending gluten-free starches and flours together creates a texture that is equal to or better than the gluten-containing counterpart. In leavened dough products, potato and tapioca starches support rise of the dough and a uniform structure that is lost without gluten. In gluten-free breaded items, potato and corn starches crisp the texture without increasing oil uptake, which can be perceived as an adverse mouthfeel.

“Our new potato-based resistant starch can be used in food products to add fiber and to reduce calories," says Smith. “It complements the texture and mouthfeel of leavened breads. In sheeted and extruded snacks, it may increase the crispness of the product, which is a desirable sensory attribute, especially in cereal."

Reducing fat in dairy-based applications can adversely affect the product’s mouthfeel; such products tend to be not as creamy as their full-fat counterparts and fall off the palate faster. “Rice starch helps maintain a full-fat mouthfeel when fat is reduced in dairy products such as pudding and yogurt," says Smith. “In addition, rice starch creates a smoother and creamier mouthfeel, even in full-fat products."

Indeed, fat plays many roles in foods, especially baked goods. “When fat is reduced or removed from a dough or batter, viscosity changes," says Gilbert. “This impacts processing, as well as the final product’s crumb and texture and, ultimately, its shelf life.

“Last year we introduced a texturant system based on modified food starch, citrus fiber and xanthan gum," says Gilbert. “It is designed to replace half of the oil in baked goods without any negative impact on finished-product texture. The end product also contains less fat, an attribute appealing to today’s health-conscious consumer."

Erickson adds, “The ingredient performs similarly in salad dressings, where it also assists in emulsification. It provides the same creamy textural properties as fat. And here’s an added bonus, it often provides a cost savings, as the stabilizer blend typically is much more economical and less sensitive to market fluctuations than fats and oils."

Beyond carbohydrates

Select protein and fat ingredients provide solids and lubricity, respectively, in some foods, and thus are recognized as texturants, too. “Traditional meat broths provide meat taste sensations to savory applications, such as broth, gravy and soup," says Xingqiu Lou, director, technical department, Proliant Meat Ingredients, Ankeny, IA. “The inherent fat in the broth can increase the body, creaminess and taste retention of these applications, especially in low-salt and low-fat formulations."

“Gelling proteins from animal sources will also improve the firmness and chewiness of formed meats," Lou adds. “These proteins can also be used in applications where viscosity is important. Even meat broth-based flavors can improve the mouthfeel of some applications," he says.

Kimberlee Burrington, dairy ingredient applications coordinator, Wisconsin Center for Dairy Research, University of Wisconsin,Madison, a part of the National Dairy Foods Research Center program, sponsored in part by the Dairy Research Institute, adds: “Dairy proteins are unique because they play variable and multiple roles. For example, in an isotonic beverage, whey proteins can provide a smooth mouthfeel that refreshes and replenishes without contributing to viscosity. In yogurt, the casein proteins form a gel when acid is produced during the culture fermentation. The more casein protein in the yogurt, the stronger the gel and the firmer the texture will be, which is why Greek yogurts are exceptionally thick."

Additional considerations

For each category of texturants, there are a variety of products available to meet a specific application's textural needs. "Some are standardized for final functionality in the application, while others are made specific to how the ingredient will be incorporated into the food product," says Quinn. And on that note, she adds, "Formulators need to consider the impact these ingredients have on processing, as they can impact heat transfer, pumpability and particle suspension, among other attributes."

Another consideration is cost. "The formulator may start off working on a cake that has the perfect texture but needs to be more cost effective," says Kuc. "One way to cut the cost could be to potentially reduce the amount of eggs in the system. The formulator will then look for an egg-replacement system that provides a similar texture to that of a cake containing the full amount of eggs. A great hydrocolloid combination for this type of application is citrus fiber with xanthan gum and gum arabic. This blend helps to build viscosity and provide a desirable emulsion that is lost when eggs are reduced."

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Sounding Off on Texture

While texture is generally thought to be purely a tactile characteristic, "food texture impacts the overall eating experience of a food product as it engages all senses from the first sight to the touch and feel, then the first bite, through chewing, to the final swallow," says Suzanne Mutz-Darwell, senior market development manager, texture, Corn Products/National Starch, Bridgewater, NJ. "It involves all the senses and is a key determinant of consumer liking." Sound can be a critical component of the experience and enjoyment of a food product—especially for snacks, baked goods and other low-moisture foods.

To develop a deeper understanding and gain insights on how consumers feel about different food textures and the terms they use to describe them, National Starch commissioned a study with a select group of consumers using a Zaltman metaphor elicitation technique (ZMET). "Since a picture is worth a thousand words," explains Mutz-Darwell, "consumers were asked to bring in pictures of nonfood items that represented food textures, and then asked to describe why they made those selections and how these textures made them feel when eating different types of products."

Professional interviewers then noted how many times different words were mentioned when describing a set of textures, and the emotions associated with them. "The analysis suggested that when consumers described crispy textures, they often associate such terms as thin, tender, light, the feeling of good for you and healthy," continues Mutz-Darwell. "On the other hand, terms associated with "crunchy" included rough, varied, surprising and were associated with being energized and exciting.

"Using sensory and Texicon™ texture language to quantify texture and sound attributes,

National Starch's sensory scientists have developed proprietary food texture language to translate the consumer experience of texture into precise, measurable, scientific terms that allow experts to help manufacturers target and achieve the perfect texture," says Mutz-Darwell. Consumers naturally use integrated consumer terms such as "crispy" and "crunchy" to describe the multifaceted texture experience of foods, she notes. "Using the Texicon language, National Starch's trained, in-house sensory expert descriptive panels and experts in rheology and materials science translate those visual, audible and oral consumer terms into fundamental expert terms that can be quantified for intensity, such as volume, hardness and graininess," she says.

The sensory team identified eight key textural attributes that helped distinguish products along the crispy–crunchy continuum, of which three are involved with the type of sound experienced during eating: volume, pitch, duration of sound, dissolvability, cracks per bite, hardness, fracturability and denseness. Using these, the researchers characterized a number of different cracker and snack products from the market, and mapped the texture space for each. For instance, for crackers, they identified four sub-groups or clusters that shared similar intensities of sounds and other key textural attributes, says Mutz-Darwell: "Crispy, crinchy™, crunchy (shattering) and crunchy (snapping). Crispy products tended to be softer, dissolved more easily in the mouth, and were shorter in duration of sound, whereas crunchy products tended to be louder and harder during chewing, and the crunching sound lasted longer."

Translating, characterizing and then formulating toward a texture target allows product designers to reach their objectives. Mutz-Darwell describes a project involving a baked cracker: “The goal in this case was to transform the cracker texture toward a more crispy market benchmark, yet achieve this target texture via a time- and cost-saving chemically leavened process versus a fermentation process."

Based on knowledge gained from mapping the baked cracker texture space, the company's scientists could characterize the current control product, as well as the desired texture target, and understand not only the differences in key textural attributes, but also their intensities. This helped to select the best snack texturizer, to optimize the formulation and to suggest process parameters.

“Ultimately, we were able to achieve the desired crispy texture via a chemically leavened formulation, thus additionally reducing the overall process time from a 16-hour fermentation process to a 6-hour chemically leavened process," says Mutz-Darwell.