Talking About TEXTURE

INSIDE

- Texture, Inclusions and Sensory Success
- Importance of Texture Measurement
- Texture Solutions for Snack Bars

Custom Digital Brief

FOOD PRODUCT DESIGN®

Innovation | Ingredients | Science | Compliance

WHAT LETS YOU MIX IN INSTANT IRRESISTIBILITY?

ALMONDS, OF COURSE.

Because when you're creating snacks consumers clamor for, no ingredient gives you the ability to add more goodness than almonds. They're tasty and crunchy and they provide 6 grams of energizing protein. What's more, almonds deliver heart-healthy nutrients, making them indispensable to snacks that'll love consumers back. Learn more about the essential almond at **AlmondBoard.com/snacking.**

california almonds®
AlmondBoard.com

Scientific evidence suggests, but does not prove, that eating 1.5 ounces per day of most nuts, such as almonds, as part of a diet low in saturated fat and cholesterol may reduce the risk of heart disease. One serving of almonds (28g) has 13g of unsaturated fat and only 1g of saturated fat.

contents

foodproductdesign.com

4 Sink Your Teeth Into This: Texture, Inclusions and Sensory Success

Far from playing second fiddle to taste and appearance, texture can be the secret weapon that assures a product's success.

9 Importance of Texture Measurement

If a consumer bites into a soggy cracker or swallows a spoon of chewy ice cream, it's unlikely she'll be back. Texture analyzers can help product designers ensure the target texture from the lab to the consumer's kitchen.

12 Texture Solutions for Snack Bars

Snack and nutrition bars used to come in one form: hard. Advances in protein technology and a palette of fruits, syrups, grains and hydrocolloids can now fine-tune the bar's eating quality, from chewy to crunchy.

Sink Your Teeth Into This:

Texture, Inclusions and Sensory Success

BY KIMBERLY J. DECKER
Contributing Editor

When Yuval Zaliouk yearns for a taste of childhood, he doesn't sink his teeth into Proust's proverbial madeleine. Rather, this symphony-conductor-turned-food-entrepreneur reaches for one of the crunchy, waferlike cookies his grandmother Dina called *petit gateau sec*—and that he now produces commercially under the Almondina brand name. "The combination of roasted almonds—the main ingredient—plus the crunchy texture and the aroma of natural vanilla give this delicious cookie its unique attributes," Zaliouk says. And the Almondina name tells a story, too, as it not only pays tribute to the grandma whose recipe made the crisp cookies possible, but calls attention to the almonds that, at 30% of the formulation, are both the cookies' main inclusion and their main ingredient, period.

The company emphasizes their abundance with transparent packaging that lets consumers "clearly see the roasted almonds prominently displayed throughout," Zaliouk says. But as inclusions, the almonds do more than provide a visual hook that catches consumers' eyes. They contribute a "decided crunch and natural, pure nuttiness that give our cookies a consistent almond flavor," he notes.

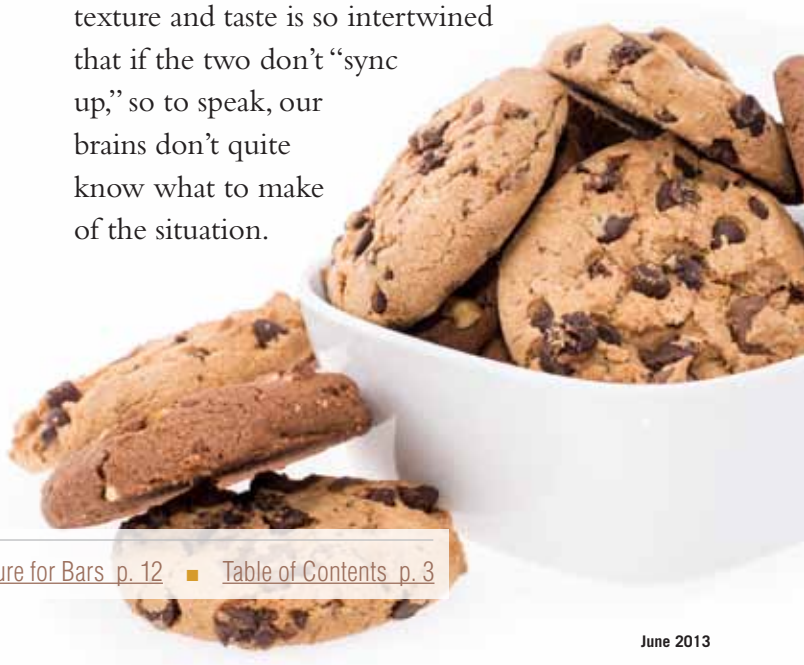
In so doing, they also demonstrate that texture, far from playing second fiddle to taste and appearance, can be the secret weapon that assures a product's success.

Mind games

Texture may not be the main sensation that characterizes the eating experience, but it's critical to the sensory gestalt underlying it. As Dale Conoscenti, CRC, research chef, Rhino Foods, Burlington, VT, puts it: "Texture is extremely important. Texture is multisensory, which means that all of our senses react to what we're chewing and tasting."

On one level, it acts as a built-in flavor-delivery mechanism, facilitating—if you plan things right—flavor release. "Texture absolutely impacts one's perception of taste," explains John Nardini, executive vice president, Denali Flavors, Wayland, MI. For example, the more quickly an inclusion melts, he says, the more powerfully we sense its flavor. So, in a chocolate chip ice cream, "We want the chocolate chip to melt at a proper rate to enhance the chocolate flavor of the ice cream," he says.

Yet at a deeper level, the relationship between texture and taste is so intertwined that if the two don't "sync up," so to speak, our brains don't quite know what to make of the situation.



IN THIS ISSUE

Texture Measurement p. 9 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

Or, as Conoscenti puts it, "Texture can be the difference between what we know and what we actually experience."

Consider an inclusion intended to convey the impression of cookie crumbles. Even if the taste perfectly replicates, say, chunks of chocolate sandwich cookies, if the texture resembles mush, the whole concept won't compute for the consumer. On the other hand, softer inclusions connote "a perception of indulgence," says Ron Heddleson, director of technical services, QualiTech, Inc., Chaska, MN, and that often leads to "an expectation of melting properties," and of a more intense flavor.

Beyond its role in reinforcing an inclusion's identity, texture can also establish a contrast between the inclusion and the base product that keeps the senses on their toes.

The takeaway is that, for an inclusion to "work" conceptually, its texture should "properly 'fit' the flavor you're presenting," Nardini says. "Caramels should be soft, chewy and/or gooey; chocolate has to melt quickly, and it can't be waxy. If we're looking at a cookie or cracker inclusion, we need to make sure it has some crunch. Cake and brownie inclusions need to feel moist, freshly baked."

Compare and contrast

Beyond its role in reinforcing an inclusion's identity, texture can also establish a contrast between the inclusion and the base product that keeps the senses on their toes—which, after all, is a major reason we enjoy inclusions so much in the first place.

Product developers can have very specific notions of what they want to get out of this textural contrast, according to Becky Pogoreski, R&D manager, inclusions, SensoryEffects Flavor Systems, Defiance, OH. "Our customers request gooey textures for baked goods," she says, "because they're looking for inclusions that give an indulgent quality to a muffin or bread—mimicking caramel, marshmallow or a fruit jelly." In frozen desserts, by contrast, they look for add-ins with a noticeable bite. "These inclusions give added flavor punch," she notes, "as well as a surprise crunchiness."

Usually, the textural sweet spot comes from following the Goldilocks model: don't go for too much contrast, don't deliver too little, get things just right. "If the difference in texture is too subtle," Pogoreski cautions, "then the consumer might not notice. But on the flipside, if the difference is too drastic, then the different mouthfeels can be off-putting. In most cases, a moderate difference is desirable."

Bill Morecraft, general manager, Blue Diamond Almonds Global Ingredients Division, Sacramento, CA, points to chocolate and almonds as his platonic ideal of the textural compare-and-contrast. "You find a great contrast between the main substrate—chocolate—and the nut inclusion," he says. "Together, they provide a creamy mouthfeel from the chocolate and the textural crunch from the almonds. While at first

Photo: Almond Board of California

IN THIS ISSUE

Texture Measurement p. 9 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

you experience the softness of the chocolate, the crunch factor adds excitement." Taking things further, he suggests using a flavored almond to differentiate this sensory-stimulating marriage even more. For example, a cinnamon or ginger profile could add sweet spice to the confection, while a salted almond would bring a savory contrast. Given that chiles and chocolate are showing up in all manner of products, a fiery-flavored almond might work here, too.

Form follows function

Morecraft notes that almonds are versatile enough to suit a range of applications: not just confections, like chocolate, and baked goods, like Almondina, but snacks, frozen novelties, bars, salads and more. "Whether you need an almond for ice cream or cereal, you can attain the desired form, be it sliced, diced, whole or otherwise," he says.

> More often than not, the threat comes from moisture migration, which saps an inclusion of its crispy or crunchy texture.

And by manipulating the almond via roasting or coating it in a sugar glaze, you wind up with even more textural options, while also landing yourself a tool for preserving the nut's texture over the long haul. And that's no small matter: As Heddleson says: "Some of the greatest challenges in inclusion development involve maintaining texture over the product's shelf life."

More often than not, the threat comes from moisture migration, which saps an inclusion of its crispy or crunchy texture. Hence the utility of processing tricks like roasting—which drives off moisture—and coatings and other formulation measures that keep moisture out of the inclusion from the start.

Heddleson notes that oil-based coatings preserve the firmer texture of cookie, cake and brownie pieces by blocking the transfer of moisture from the surrounding environment. His team "employs unique coatings to encapsulate seasonings for pretzels or breads, which help to keep the appearance and texture intact during baking," he says.

But not all inclusions are best enjoyed al dente. Chocolate-flavored pieces for use in frozen applications are a case in point. "Consumers prefer to experience chocolate as if they were eating it at room temperature—it has to simulate the melt point of a candy bar at room temperature to allow for the flavor to take hold," Nardini explains. In a product eaten at 5 to 10°F, a chocolate piece that's "frozen like a brick," he says, "misses on both textural and flavor points, so we have to be creative when developing these ingredients so they hit the market with consumer expectations." That means replacing cocoa butter, whose melt point is 88°F, with vegetable fats that melt at 76°F or lower. This not only makes the chocolate-

IN THIS ISSUE
Texture Measurement p. 9 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

flavored piece edible in the frozen application, but improves flavor release as the piece melts in the mouth, as well.

Heddleson adds that "most indulgent sweet inclusions need to be soft and exhibit some degree of melting when baked." By formulating with texturants like gums and starches, as well as with lower-melting-point fats and other functional ingredients, his team creates add-ins that "deliver customized degrees of melt in indulgent chocolate and fruit-flavor delivery systems," he says. "These are often needed in bakery applications, delivering the appearance of fruit in muffins, pancakes or waffles."

When Conoscenti and his team build inclusions, "We consider the whole texture experience: soft and chewy, sugar granulation, firmness of the chip, everything," he says. Echoing his colleagues, he agrees that coatings are handy for keeping moisture out, and he also advises product developers to be careful when adding inclusions to yogurt, which has a high acid content that can deteriorate product.

Nuts in all their forms are also attention-getting inclusions that signal texture visually and deliver it when eaten.

"Unless you can equilibrate your inclusions close to the baseline pH of your yogurt," Conoscenti says, "you'll see very quick deterioration—within 24 hours." He's found that fruit granules and extruded pellets—whether flour- or dairy-based—are particularly vulnerable to yogurt's acid attack. "And the only way to combat that kind of issue is to coat the inclusion," he says. Oil-based compound coatings work best, but even then "it gets tricky because of the pH," he concludes. "There's always a balancing of the pH of your environment—the yogurt—with the pH of your coating." And if all else fails, you can always "exclude" your inclusion by packaging it in a cup or compartment separate from the yogurt itself, as with Chobani's Almond Coco Loco Flip, which sequesters the toasted almonds and dark chocolate chips from the coconut-flavored yogurt.

From a visual perspective, Conoscenti recommends using a compound or chocolate chunk instead of a chip in baked goods because its "big flavor profile and visual appeal create consumer anticipation," he says. "Bigger chunks produce bigger flavor intensity, and give a perception of more 'bang for the buck.'" And sugar crystals with a noticeable granulation size also go a long way toward reassuring consumers that there's "real" sugar in their beloved clumps of cookie dough—not some "artificial" syrup they may be wary of, justifiably or not.

Nuts in all their forms are also attention-getting inclusions that signal texture visually and deliver it when eaten. Conoscenti learned this firsthand during his decade working in R&D for Ben & Jerry's Ice Cream. "We used every kind of nut you can imagine, from Brazil nuts to peanuts to almonds," he says, and he found that key to maintaining their textural appeal was storing and handling them properly. He recommends freezing nuts in vacuum packaging and using them as close to freezer temperature as is possible in your process. "Freezing really maintains freshness," he notes, "along with texture and a clean, un-oxidized taste."

Having done that, product developers can accentuate texture with compound coatings, which he says lend crunchiness, or by using different sizes and shapes. "If you use nut halves and quarters," he points out, "the quarters—or

IN THIS ISSUE
Texture Measurement p. 9 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

pieces, or chops—get good distribution through the mix, while the halves give you show."

And even if you're working with a sweet application, don't forget the salt. Conoscenti recalls frequently using salted nuts—anywhere from 0.5% to 2% salt, he says—in ice cream. "If you have a really sweet product, like a sweet ice cream that has sweet variegates and maybe a candy piece in it, then you want to salt and roast the nut to give you that balance of the sweet and the salty," he says.

Status update

Such formulation nuances bolster an inclusion's premium cred—which, in an environment where a subset of consumers consistently demonstrates its willingness to shell out for "luxury" foods, can make the difference between being noticed and fading into the background. Put simply, inclusions that come by their textural appeal "naturally" score points.

In the end, creating the ideal inclusion comes down to approaching the task with the mindset—and palate—of a consumer.

That's music to Morecraft's ears. He cites research from Innova Market Insights singling out almonds "in all their forms" as the top nut in new product launches with a premium positioning. "Four of the five top market categories for global product launches revealed that products containing almonds had a substantial price premium over products that did not," he says.

And when you consider that consumers often treat "premium" and "real," "whole" or "natural" as two sides of the same coin, their fondness for almond inclusions makes even more sense.

"Part of the reason that consumers demand 'real' ingredients," Morecraft says, "relates back to their making healthier choices and wanting healthier ingredients in their food." Almonds fit the bill, he says, which is why they "remain one of the top nuts that not only provides a great deal of nutritional benefits, but that offers a unique and satisfying crunch and texture unlike any other nut."

In the end, creating the ideal inclusion comes down to approaching the task with the mindset—and palate—of a consumer. That means putting the emphasis on multisensory satisfaction. "It's a combination of taste, texture and appearance that determines the ultimate quality of an inclusion," Nardini says. "You have to deliver on all three because the consumer has an expectation that needs to be met. An inclusion that is spot-on in terms of flavor, but off on texture will not survive as a premium item. It must deliver on all three facets."

Kimberly J. Decker, a California-based technical writer, has a B.S. in consumer food science with a minor in English from the University of California, Davis. She lives in the San Francisco Bay Area, where she enjoys eating and writing about food. You can reach her at *kim@decker.net.*

IN THIS ISSUE

Texture Measurement p. 9 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

Importance of Texture MEASUREMENT

BY MARC JOHNSON
Contributing Editor

Texture is one of the most important characteristics of a food: If a consumer bites into a soggy cracker or swallows a spoon of chewy ice cream, it's unlikely she'll be back. Texture analyzers can help product designers ensure the target texture from the lab to the consumer's kitchen.

Texture measurement is an increasingly critical component of every food company's product development effort. Many external forces on food companies impact the texture of their products and can affect consumer acceptance (new products, health demands, supplier changes, ingredient changes, etc). Companies are increasingly quantifying these impacts with modern texture analyzers.

The following four trends are forcing food manufacturers to change their product development efforts:

- Constant pressure for companies to reformulate their products
- Companies must do much more with fewer staff and resources
- Companies need regular feedback on the texture of their products for their product development and manufacturing efforts
- Consumers are increasingly demanding products with sophisticated or subtle textures.

Reformulating products

Food manufacturers must be responsive to consumer demands and trends, no matter how lasting or fleeting those trends are. Consumer expectations often are very difficult to achieve, e.g. gluten-free pizza with the same textural qualities as one made with normal wheat flour.

Trends with textural implications include the demand for products with low salt, low fat, fewer carbs, gluten-free and less sugar. Consumers increasingly want foods with simpler ingredient labels, higher nutritional content, or ingredients that achieve certain health claims. Reformulation demands can also be due to business reasons such as the need for alternative ingredients or suppliers to meet cost-reduction goals. Some trends, such as healthier vegetarian products or products with cleaner, simpler labels, may have longer staying power because they appeal to new generations of younger consumers.

While some of these trends may be fleeting, new companies and products have emerged to serve these markets, so opportunities should not be discounted. All require manufacturers to quantify the textural implications of different formulations on their existing, brand-extension, and new products.

Doing more with less

Companies have become more efficient and streamlined their operations, so laboratories that are staffed with fewer scientists and factory floors with fewer QC technicians. However, workloads have increased with a proliferation of new products, brand extensions, packaging variations and production volumes. So that fewer workers can do more with less, instruments must be flexible enough to quantify the textural attributes of as many products as possible. Additionally, the

IN THIS ISSUE
Texture p. 4 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

same instruments are often dual-purposed to test product packaging. This allows all scientists and technicians to conduct the necessary texture analyses on the same instrumentation and software platforms.

As consumers have demanded products with more subtle textures, the methods capable of discerning differences have also become more sophisticated. Companies need to conduct increasingly more complicated texture tests, requiring texture instruments which can perform these complicated analyses with very simple user interfaces.

"Push-button simple" deployments of flexible texture analyzers allow companies to maintain production and development velocities with fewer instruments, fewer employees, and lower training costs.

Instrumental textural analysis

Sensory panels still remain absolutely vital tools for companies as they benchmark products against consumer expectations. However, sensory panels are expensive to train, are not easily deployed for the duration required for comparisons of multiple formulations and batches, and cannot be deployed across multiple shifts and multiple plant locations. Internally maintained panels can also be politically influenced by the participation of senior management.

Companies are increasingly establishing instrumental texture methods for their products which correlate with sensory judgments. They can then deploy texture analyzers in R&D labs or quality control situations. Plus the instruments can be used during all shifts and across multiple plants. Texture analyzers can also discern the impact of subtle formulation changes more clearly than sensory panels.

Texture analyzers offer practical, cost effective, flexible and precise solutions for meeting the ongoing need for textural evaluations of both new formulas and production batches.

Analyze this: The instrumentation

Texture analyzers are instruments that measure force as products are compressed, punctured, snapped, sheared or pulled apart. High quality texture analyzers work by combining sensitive calibrated load cells, precise stepper motors with programmable machine instructions and intelligent analysis. Fixtures and probes are mounted on the load cells and driven into target products in order to imitate consumers' experiences. For example, to imitate a consumer biting through an extruded cheese puff, a thin knife blade can be mounted on a texture analyzer and driven into the snack at speeds comparable to someone's jaw (See Picture 1 and Figure 1).

Picture 1

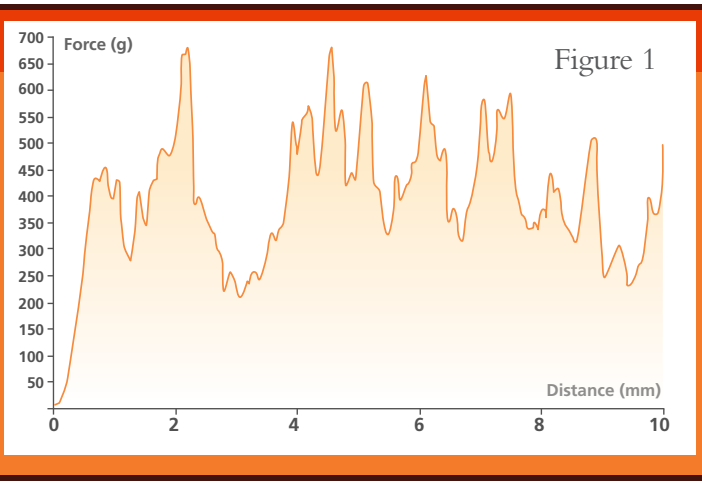


Figure 1

IN THIS ISSUE
Texture p. 4 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

The resulting force curve will show increasing force from when the blade encounters the product's exterior until it breaks into the snack. That section of the plot will correlate with consumers' sensory perceptions of stiffness and brittleness. As the blade cuts through the subsequent internal cells, the force plot will have a jagged profile, which will correlate with sensory scores for hardness and crunchiness. Some instruments have a program that automatically analyzes the curve and provides quantifiable metrics about crispness, brittleness, hardness, and crunchiness and how all of those parameters change over time.

Almost every type of food product can be similarly tested with a variety of fixtures and probes. While each combination will generate a different force profile, almost all of them can be tied back to consumers' sensory judgments or to product behaviors that are relevant to food manufacturers.

Textural expectations

Retail and industrial customers now have much more refined expectations of desired product textural attributes. The demand is being met with increasing numbers of new products, brand extensions and formulations. Just look at consumers' appetite for coated crunchy products, nutrition and granola bars of every type, as well as new styles of yogurts. Low-end texture analyzers only measure a "soft vs. hard" scale which cannot even discern the targeted, subtle attributes key to products with nuanced textures.

More skilled manufacturing and packaging techniques can deliver the desired textural attributes that customers are now demanding (e.g. crispy, crunchy, brittle, resilience, creamy, thick, chewy, tough, slippery or crumbly). However, these attributes need to be measured and maintained throughout the products' shelf life, which can only be quantified with full-featured texture analyzers with sophisticated software packages. High-end texture analyzers with calibrated microphones can even capture the acoustic profile of crispy and crunchy products. All of these tools and techniques, along with sophisticated software that automatically calculates textural attributes relevant for individual products, have allowed manufacturers to cost-effectively precisely quantify and control the highly desired textural attributes that consumers are demanding.

Armed with better tools and a lexicon to describe textural attributes, food scientists today can now measure subtle differences in texture.

Armed with better tools and a lexicon to describe textural attributes, food scientists today can now measure subtle differences in texture. These measurements help them quickly create reformulated products that retain all the desirable characteristics of targeted products without compromising important elements such as mouth feel.

Market forces and recession economics have changed the balance of power between food manufacturers and consumers. Companies are reformulating their products more often, conducting product development efforts with fewer resources, requiring more testing of products' textural attributes, and delivering products with more sophisticated or subtle textures. Using advanced texture analyzers in food product development and production efforts effectively addresses each of these challenges.

Marc Johnson is president of Texture Technologies, the North American distributor of Stable Micro System's family of texture analyzers. He joined Texture Technologies in 1993 and has been developing test methods and fixtures for quantifying the texture of food products for the last 20 years. He is a frequent lecturer at industry, university and corporate meetings on topics related to texture measurements for the food, pharmaceutical, cosmetic and adhesive industries.

IN THIS ISSUE

Texture p. 4 ■ Texture for Bars p. 12 ■ Table of Contents p. 3

EDITORS' REVIEW

- Managing water activity to prevent bar hardening and extend shelf life.
- Protein ingredients—including soy and whey—that add nutrition and texture to bars.
- Ramping up texture with grains, nuts and other inclusions.

Texture Solutions for Snack Bars

BY CINDY HAZEN
Contributing Editor

No matter the flavor, snack and nutrition bars once came in one form: hard. However, advances in protein technology and a rich palette of fruits, syrups, grains and hydrocolloids can now fine-tune the bar's eating quality, from chewy to crunchy. Yet, the most-important ingredient to consider comes right from the tap.

Water, water everywhere

Nutrition bars, if not formulated correctly, will harden upon storage. "Water activity (a_w) is directly related to rate of bar hardening, as well as bar shelf life," explains Luping Ning, associate science fellow, The Solae Company, St. Louis. "Water serves as a plasticizer in nutrition bars and helps to maintain the structural flexibility of the bar matrix. Therefore, bars with higher a_w value will have a higher amount of available water to act as a plasticizer to keep the bars softer. Bars are considered shelf stable and are typically produced without a final thermal-processing step, or kill step," so bars will need to maintain an a_w less than 0.65 "for food-safety reasons."

Managing the movement of water in the bar matrix is especially important when the bar contains a high amount of protein. "Water tends to migrate from binders, such as syrups, into proteins or other dry ingredients after bars are produced" which means that, over time, syrups lose their ability to act as a plasticizer, Ning says. Proper selection of proteins is key to minimizing water migration and maintaining softness throughout shelf life.

"With bars, it all comes down to using the right ingredients from the beginning to hit the final product specifications. Not all proteins

IN THIS ISSUE
Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

work the same in all bars, because not all bars are alike. Developers need to work closely with their suppliers early in the process to get the right ingredients for their specific bar system," says Courtney Kingery, marketing manager, specialty products—oilseeds, ADM, Decatur, IL.

For the joy of soy

As the bar market has matured, the quality of ingredients has improved. "Soy proteins have long been a cost-effective alternative to other protein sources in a bar, but can sometimes have detrimental effects on bar hardness and shelf life," says Kingery. Special processing of soy protein minimizes the hydrophilic tendencies sometimes associated with them. "The result is lower water migration to the proteins, more consistent bar texture over the shelf life and reduced bar hardness," she says. Today's soy protein isolates provide high protein (90%) and a wide variety of functionality and texture options, "from a short, cookie-like texture to a chewy or fudgy bite," she says.

> Regardless of the type of protein used, higher levels will impact the bar more than low levels.

Ning notes that using isolated soy protein in nutrition bars provides clean flavor, high protein content, ability to extend bar shelf life, superior machinability in bar processing and low cost, compared to dairy proteins. She recommends combining dairy and soy proteins, suggesting that internal sensory research "confirms that bars featuring a combination of dairy and soy proteins actually have better taste and texture than those formulated with dairy proteins alone.

"Soy protein crisps or nuggets are commonly used in bars, and also provide a nutritionally complete, high-quality protein, and provide crispness and crunchy texture," continues Ning. "Soy protein nuggets also help to reduce the bar density and the calorie density of a bar." The company recently launched a nugget with 90% protein on a dry-weight basis.

"For bar systems that call for some crunch, our textured soy concentrates are a cost-effective option to protein crisps," says Kingery. Ultra-high-protein crisps offer 90% protein on a moisture-free basis. For bar manufacturers looking to respond to the consumer shift toward more-moderate levels of proteins, the company manufactures a line of soy protein concentrates that combines high-quality proteins (70% protein) with low flavor profiles.

Minimally processed soy flour "is an excellent option for baked cookie bars, or for use as a component to a gluten-free flour blend," Kingery says. The soy flour delivers 53% protein with minimal impact to flavor and texture.

Wheying in

Regardless of the type of protein used, higher levels will impact the bar more than low levels. "It is important to find that balance between nutritional value and long shelf life," says Starla Paulsen, applications manager, Glanbia

IN THIS ISSUE
Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

Nutritionals, Monroe, WI. Her company produces whey protein isolates, whey protein hydrolysates, whey protein concentrates and "specialty whey fractions and peptides, designed specifically for bars that deliver good texture and flavor."

According to Grace Harris, manager, applications and business development, Hilmar Ingredients, Hilmar, CA: "Whey proteins influence bar texture in a variety of ways. Whey protein concentrate and whey protein isolate can be used to add shortness or chewiness to a bar, and whey protein hydrolysate adds softness. Whey proteins used in combination can aid in overall water binding, a_w levels and flavor of the bars."

Whey proteins can also be incorporated into whey crisps and nuggets. "These can be used as nutritional substitutes for cereal-based ingredients," says Gwen Bargetzi, director of marketing, Hilmar Ingredients. Whey crisps, with a full complement of amino acids, "can boost lesser-quality proteins, such as plant proteins, to provide optimum nutrition," she says.

In a 2007 *Journal of Food Science* study, (72(6):S425-S434) researchers found that consumers preferred the meal-replacement nutrition bars made with whey, or a combination of whey and soy, to the bars made solely with soy. This is because the soy protein bars were harder and characterized by high fracturability, lack of cohesiveness and "production of many particles during chewing," the researchers note.

Photo: Ocean Spray Cranberries, Inc.

Customizable whey protein crisps—adjusted to suit varying flavor, color and texture needs—can improve bar acceptability. "Usage levels can be tailored to meet the customer's desired protein level in the finished snack bar," says Jeff Banes, applied technology manager, Grande Custom Ingredients Group, Lomira, WI. "With crisps ranging from 25% protein up to 70% protein, we can help select the appropriate protein level crisp, based on how much room there is in the formula and the desired protein level of the finished snack bar. This usually turns out to be somewhere between 10% and 30%. The most-common protein levels requested are 50%, 60% or 70% protein. Texture is dependent on the protein level, with crispier textures at lower protein levels." A whey protein crisp from the company was one of the whey proteins used in the *Journal of Food Science* study deemed desirable by participants.

It's important to note that whey crisps cannot be added to a nutrition bar without significantly altering the texture and taste, "as their crunch and flavor is very distinctive," cautions Paulsen.

High-protein crisps "allow the bar manufacturers to avoid having to solubilize and incorporate viscous high-protein solutions," says Pamela Sander, Ph.D., president, Zumbro River Brand, Albert Lea, MN. "The primary role of high-protein whey crisps is to provide snack bars with protein."

Hydrolyzed whey protein can also be used in producing crisps for more-rapid utilization of the amino acids in the body. "Inclusion of hydrolyzed proteins can also be useful if problems of hardening develop in bar storage, as the peptides in hydrolyzed

IN THIS ISSUE

Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

whey protein have less tendency to draw moisture from other ingredients than do longer-chain proteins," Sander says. "Hydrolyzed whey proteins can have bitter flavors, and the incorporation of sweeteners or flavors into the crisps can help to minimize this issue."

Grains to go

Formulating with whole grain can add nutritional claims, as well as texture. Terry Gieseke, director sales and marketing, J.R. Short Milling Company, Kankakee, IL, advocates using extruded intermediates to deliver a "good source of protein" or a "good source of fiber" claim.

"Using whole ground corn, whole-grain wheat, whole brown rice and whole oats, individually or in combination, we can deliver whole-grain and multi-whole-grain claims with a hearty crunch and delightful toasted flavor," says Gieseke. "By using multiple grains and starches, you can achieve high expansion with an airy, crispy texture to contribute volume and a very neutral flavor base. With this same base formula, we can include internal flavors like vanilla or cinnamon to deliver a lightly sweet aftertaste, or even cocoa powder for a signature flavor base. These characteristics can be formulated and produced to specifically avoid gluten content."

Three categories of grain inclusions are available for bars: flakes, coated grains and clusters, notes Bill Bonner, senior vice president R&D, 21st Century Grain Processing, Kansas City, MO. Milled whole grains from oats, wheat, barley and rye "can be in whole-flake or quick-flake formats, and are generally used in cereal bars that are baked," he says. "Choosing the right flake, whole versus quick, impacts the texture around how the flakes compact together and, thus, chew resistance."

Simple coated grains are typically used in chewy bar applications. These have milled grain properties. However, "the application of designer coatings alters texture in the final product," Bonner says. "Since these products are usually sweet, the ratio of reducing sugars to nonreducing sugars impacts the coated-grain component in a bar. Other texture characteristics are adjusted by total sugars, oil inclusions and flavor release through reaction compounds. These prebaked, coated grains are normally custom-designed for the specific bar application and can be enhanced nutritionally with protein and fiber to affect texture and nutrition density."

The third adjunct for grain-based texture is cereal clusters, "where one builds in a lighter, expanded component with the whole-flaked grains," Bonner says. "These result in less-dense, air-containing bars. The expanded components of choice in this application are fiber and protein crisps. The similar coating application to the cereal component gives the same advantage as does the simple coated grains in designing texture."

> A variety of textures and close attention to a_w balance is a key part in developing and shelf-life determination in these products.

Be aware that using small, uniform components can create a bar that is too compact. "This may also lead to shelf-life limitations where the bar equilibrates in moisture and becomes tough to chew," Bonner says. "A variety of textures and close attention to a_w balance is a key part in developing and shelf-life determination in these products."

Kingery notes that "an emerging group of ingredients—ancient grains and gluten-free flours—brings an additional level of complexity for bar formulators. A blended solution often works best. For example, most gluten-free flours include a blend of rice, potato and/or tapioca flours. Adding

IN THIS ISSUE
Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

soy flour to that matrix helps with cohesion and reduction of brittleness of the finished product."

Whole-grain and multigrain ingredients have unique characteristics that must be planned for in the formulation. Kingery suggests adding a blend of isolated wheat proteins that deliver 80% to 90% protein. "Baked bars that include a blend of soy and wheat proteins often see better cell structure, better bite and less of a doughy-like, or undercooked, texture," she says.

Focus on fiber

Fiber not only adds an important nutritional component to bars, but it also increases the shelf life of bars by improving water binding and retention during processing and storage of finished bars. Ramakanth Jonnala, Ph.D., R&D project leader in baking, International Fiber Corporation, North Tonawanda, NY, says fiber increases viscosity in sticky bars without having to use excessive thickeners. "It increases the flexibility of bars, reducing breakage in brittle products," he says.

Nutrition bars are usually made by cold extrusion. "Hard or chewy or dense textures are a common problem," Jonnala says. "Addition of fibers can modify the texture of these bars, making their consumption easier for those who do not like chewy and/or dense products. Fiber can enhance the rate of extrusion, because fibers are shear-resistant and withstand higher temperatures."

Jonnala recommends using oat fiber at 2% to 3% of the formulation. "High levels could impact the mouthfeel of the finished bar," he says. Sugar-beet fiber is ideal for granola-type bars. Typical usage is 3% to 5% of the formulation. Cellulose, wheat fiber and sugar-cane fiber can be used in breakfast cereal bars, meal-replacement bars and low-carbohydrate bars. A typical usage level would be around 5%.


Photo: BENEO-Orafti, Inc.

Joseph O'Neill, executive vice president of sales and marketing, BENEO-Orafti, Inc., Morris Plains, NJ, suggests adding inulin or oligofructose to bars. While this offers fiber enrichment, inulin can also "be used as a binder in combination with other binding syrups. It may also be a functional component in extruded cereal pieces or as part of the recipe to aid in shelf-life extension or partial sugar replacement," he says. "Chicory oligofructose syrups can be the sole binding syrup, contribute to textural modification of bars, and aid in caloric reduction and partial sugar replacement."

Fruit and nut options

Many nutritional bars on the market today contain various forms of fruit. "Concentrated fruit juice is sometimes incorporated as a natural sweetener, and can deliver a point of difference in flavor and color," says Doug Webster, technical services manager, Tree Top Inc., Selah, WA. "Concentrated fruit purées have high levels of humectant properties and are used to replace fat while maintaining a soft texture in some bar formulas. Low-cost dried-fruit powders, such as apple or pear, can be added to the binder to deliver some fruit and also assist with moisture control. These fruit powders are available for most types of

IN THIS ISSUE
Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

fruit, and are sometimes applied topically to bars for a visual point of difference."

Larger inclusions can be colored for a visual cue. "Dried or infused apple dices with an a_w of 0.50 deliver a soft fruit texture." Webster says. "To keep the carbohydrate levels lower, using a small dice or granule will increase piece count per bar." The company can also "infuse apple dices with high-fiber syrups like polydextrose or inulin," he says. "This greatly reduces the total sugar content and may allow a fiber claim. Other natural fiber options include the use of unpeeled apple dices or apple fiber in powder form." The company's apple fiber contains approximately 70% dietary fiber.

The amount of fruit used can also be dependent on the style of bar. "If the nutritional bar is an extruded bar containing a fruit filling, the fruit content can be as high as 35%," says Webster. "Frequently, we see fruit used at 7% in this type of application. I typically suggest starting with 3 to 5 grams fruit per bar and adjust according to nutritional requirements. These levels will deliver about one-quarter of a fruit serving, depending on the finished bar size. Very little formula adjustment is necessary aside from accommodating the higher carbohydrate content of fruit."

Moisture of dried fruit can be adjusted to match the a_w of the bar or a desired texture profile. "Long term, the texture of a bar may change if a proper moisture range is not chosen when formulating," Webster cautions. "It is important to match the a_w of the bar to prevent moisture migration. Color can also be impacted, with some fruit options becoming brown in storage.

"Apple and pear are neutral in color," Webster continues. "We don't see a color bleed in most applications. Some of the berry and exotic fruit powders will most likely transfer color pigments to your matrix. Adding high-color fruit ingredients at the end of the process could reduce the amount of bleed. Of course, that is dependent on the type of bar-manufacturing process."

Dried plums improve bar taste, texture and nutrition, notes James Degan, consultant, California Dried Plum Board, Templeton, CA. "Dried plums help to naturally bind moisture, round-out and enhance flavors, and are a rich source of antioxidants, fiber and potassium," he says.

Adding dried-plum powder and fresh plum-juice concentrate to energy bars provides added moisture and a more-desirable texture "that is often lacking in these products," Degan says. "This product improvement is due to the naturally occurring fiber and sorbitol in dried plums."

Sweetened dried-fruit ingredients offer "a convenient alternative to fruits that are difficult to process," says Kristen Borsari, global senior marketing manager, Ocean Spray Ingredient Technology Group, Middleboro, MA. The company offers a range of ingredients that includes orange, mango, raspberry, strawberry, cherry, blueberry and pomegranate. "Sweetened, dried cranberries are

IN THIS ISSUE

Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

available in a number of sizes, whole, sliced, diced and double-diced," she says, recommending double-diced fruit when smaller, more-evenly spaced pieces are needed.

Nuts are popular additions in bars to add crunch and more. "At a very conservative 5%, you will notice increases in the crunch, texture and flavor from sliced or diced almonds," says John Cukor, culinary expert, Almond Board of California, Modesto, CA. "If the goal is to reduce carbohydrates and increase protein, then almond flour or meal can be substituted for 20% to 40% of the formulation. Almonds, however, can be used in even higher levels in formulations." A gluten-free concept bar that was nearly 75% almond ingredients used more than six different almond forms, including meal or flour, butter, and paste.

Refining texture

Two main categories of ingredients impact the texture of bars: sugars and/or sugar replacers and hydrocolloids, notes Laura Quinn, senior application technologist, multiple food applications, Danisco USA, Inc., New Century, KS.

"The sugars or sugar replacers that make up the binding syrup are going to be approximately 50% of a granola-type bar," Quinn says. The particulates make up the other 50%. Hydrocolloids would typically be less than 2% of the bar, whether a granola type or high-protein dough type.

"In a granola type, the sugars are going to give the biggest impact on texture," Quinn continues. "The type of sugars used dramatically influences the texture. For example, fructose softens the bar texture, reduces the a_w, and improves sweetness profile and taste of the fruit in the bar. The final moisture of the binding syrup, as well as the ratio of binding syrup to particulates, changes the texture of the bar." A granola-type bar with a higher level of binding syrup, or a syrup with higher moisture, will be more chewy and softer than a bar with less binding syrup or moisture.

Hydrocolloids "can also be used to soften or shorten the texture in bars, in binding syrups or protein dough types," Quinn says. "They can help to maintain softness in the high-protein type by binding water and have a dramatic effect on extending the shelf life."

Maureen L. Akins, M.S., applications manager, TIC Gums, Belcamp, MD, says: "High concentrations of anything can negatively impact the texture of a bar. The key is to ensure an adequate balance of texturizing ingredients and functional components to limit the negative impacts that can occur. Using hydrocolloids is a great way to enhance the texture of your bar formulation. There are many different types of gums that are suitable for bar-type products, but it just depends on the finished form you are looking to achieve. Gum arabic acts as an excellent binding agent for particulates and also contributes substantially to the soluble-dietary-fiber content of the finished bar. Additionally, guar gum or cellulose gum can act as effective water-binding agents to better control the textural characteristics over the shelf life of the product."

Bar hardening is generally a function of water migration out of certain components, like proteins or starch. "While you can't stop the movement of water in a system, you can add water-holding components, such as gums, to minimize the impact of this movement," Akins explains.

Cindy Hazen, a 20-year veteran of the food industry, is a freelance writer based in Memphis, TN. She can be reached at *cindyhazen@cs.com*.

This article originally appeared in the June 2010 issue of **Food Product Design**.

IN THIS ISSUE

Texture p. 4 ■ Texture Measurement p. 9 ■ Table of Contents p. 3

FOOD PRODUCT DESIGN®

PUBLISHED BY
VIRGO PUBLISHING, LLC
CORPORATE HEADQUARTERS
3300 N. Central Ave., Suite 300
Phoenix, AZ 85012
Phone: 480/990-1101
Fax: 480/990-0819
Email: foodproductdesign@vpico.com
Website: foodproductdesign.com

MEMBER OF:
- National Assn. of Flavors and Food-Ingredient Systems
- Flavor and Extract Manufacturers Assn.
- American Assn. of Cereal Chemists
- Food Update Foundation
- Canadian Institute of Food Science and Technology
- American Society of Baking
- American Dairy Science Assn.