



## Flavoring Dairy Products

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Set a glass of chocolaty-sweet milk next to a ripe wheel of Epoisses—a cheese so aggressive that even the French have banned it from public transit—and you may wonder how such dissimilar foods could claim the same parent: milk. Pull yogurt, ice cream and that distant relation alfredo sauce into the family picture and the message is clear: dairy is one diverse clan.

Given that diversity, product developers hoping for a universal strategy for flavoring dairy might as well quit. “Every ingredient can have a different impact on the delivery of flavor within a dairy system,” says Scott Harris, segment director, Givaudan, Cincinnati. “You have to employ varying approaches to offset those elements that can mute flavors, as well as those that can enhance characteristics within a system and deliver flavor to the palate.” By tapping the wisdom of flavor experts, your entire dairy lineup can come out tasting like one big, happy family.

### Dairy’s flavor foundation

Diverse though dairy may be, the category’s foods and beverages share commonalities that form a sort of flavor foundation. According to MaryAnne Drake, Ph.D., professor, sensory analysis and flavor chemistry, North Carolina State University, Raleigh, and sensory lab director at the university’s Southeast Dairy Foods Research Center, the “basic building blocks” of that foundation are the milk’s fat, lactose and proteins.

Whether these building blocks turn into fresh, delicate, creamy notes or a bold, sulfurous, nutty profile “gets down to how processing steps, composition or fermentation break down dairy’s components into compounds that contribute flavors,” Drake says. The formation of dimethyl sulfide, 2-acetyl pyrroline and 2-acetyl thiazoline, for example, results in cooked flavors, whereas lactones and other fat-breakdown products lend creaminess. As for strong, nutty flavors, they might come from 2- and 3-methyl butanal.

### Enter the matrix

Dairy’s fat-sugar-protein matrix gets into the game itself. Consider what happens when you pare back the fat and sugar in a strawberry yogurt. “Reduction of fat and/or sugar will have a

noticeable effect on flavor and mouthfeel," says Pam Gribou, director of cheese and dairy flavor development, Givaudan. Designing a flavor that measures up to the original thus "requires an understanding of the partitioning and binding effects with the flavor chemicals, and using this knowledge to optimize a flavor system to compensate for these effects," she says.

For starters, fat balances flavors, coating the palate and "keeping flavor residing there longer," says Marie Cummings, manager, food applications and product development, David Michael & Co., Inc., Philadelphia. "So, if you decrease the fat in dairy foods, flavor release happens more quickly and dissipates faster from the mouth." Less fat also diminishes creaminess, smoothness and viscosity.

"Fat reduction affects retronasal aroma perception, since many of the volatile chemicals in the flavor system are lipophilic," adds Gribou.

Like fat, sugar builds body in yogurt, so its removal will "decrease some of the mouthfeel and 'linger' that occur in the full-sugar system," Gribou continues. But the more obvious effect of sugar reduction "is the increase in acidity perception and actual fruit-flavor display," she says. Replacement with alternative sweeteners warrants its own set of flavor adjustments, including restoring sugar's upfront sweetness and masking any bitter or metallic notes the alternatives bring along.

By increasing the relative level of protein, sugar and fat reduction "plays a major role in flavor release based on the protein-binding and absorption of certain flavor chemicals in the aqueous phase of the yogurt," Gribou says. "Again, this can impact the retronasal aroma perception because of the nature of the chemicals that are most often involved in the binding or adsorption and changed flavor release compared to the full-fat yogurt."

## **Going Greek**

Makers of Greek-style yogurts, take note. These products are not only characteristically low in fat and high in protein, but as the current "it" trend in yogurt, they're changing popular tastes in the category. "Along with the creamier texture of the strained yogurt," Cummings says, "tartness has returned. These yogurts are almost reaching sour cream in flavor."

It's one more stage in an evolution that's taken the U.S. yogurt category almost full circle. "Over the past 30 years, plain yogurts have gone from having a tart-to-mild profile to being tart with a creamier texture and flavor," Cummings says. In the 1980s, "the first fruit additions to yogurt were adding preserves at 65 °Brix. Then in the 90s, consumers asked suppliers to cut the sweetness back, so a combination of sweetness reduction and the advent of artificial sweeteners really reduced the amount of sugars per serving." It also required flavor adjustment: "Fructose has been included in combination with sucrose or artificial sweeteners at a low level to add more upfront sweetness and quicker flavor delivery," she says. "Newer sweeteners such as sucralose and stevia are also being explored."

The past decade has seen more mild-cultures, the addition of cream and "alternative-dairy" ingredients, whipped yogurts and products with thicker, creamier textures—like those Greek-

style versions. "All these changes create opportunities to achieve desired new flavor profiles," Cummings says.

But the more things change, the more some stay the same. For example, chocolate remains a yogurt rarity. Why? "Once chocolate drops below pH 6.0, it becomes fruity, sour and not recognizable," Cummings explains. Formulators can circumvent the mismatch by pairing chocolate with a fruit like cherry or raspberry. "Pie and cake flavors containing fruit introductions have also been numerous and done well in yogurt," she adds. "You just don't see many neutral-type flavors without fruit."

### **Milking moo juice**

The opposite is the case in flavored milk. "Chocolate, vanilla and strawberry are still the classics," Scott says. Caramel, fudge and other sweet browns, as well as banana—often paired with strawberry—are top-scorers, too. The choices make pH sense.

"The pH of milk is about 6.8, so it's considered a neutral beverage," explains Bill Graves, senior vice president, product research, Dairy Research Institute, Innovation Center for U.S. Dairy, Rosemont, IL. And, because like pairs with like, neutral-pH flavors like crème brûlée, eggnog, toffee, custard and praline shine in flavored milks and dairy creamers. By contrast, the acidic fruit profiles that are yogurt mainstays do better in similarly acidic beverages—say, fruit-and-dairy smoothies.

"It's challenging to get fruit flavors to pop in a low-acid beverage like milk," Cummings admits. But that's not to say that fruity milk is out of the question, as strawberry proves.

Banana is milk-friendly, too, because its pH of 4.5 to 5.2, while lower than milk's, "is still higher than some citrus fruits like orange, which ranges from pH 3.0 to 4.0," says Graves. Peach and other subtle fruits may struggle in milk, but they can work by playing up the dairy angle. "So, instead of fresh orange-juice notes, the flavor is described as 'orange cream' or 'peaches and cream,'" he says.

Processing conditions affect milk flavor. UHT and ultra-pasteurized products may display stronger cooked notes that "make some of the fresh fruit flavors more challenging to deliver," Graves says. Because milk loses stability if it encounters acid prior to pasteurization, he cautions that using fruit flavors that have an acidic background—citrus, for example—can be difficult.

Cummings points out that although flavored milk may help shore up consumers' calcium reserves, it also puts sugar in the spotlight. "With childhood obesity and an increasing awareness of diabetes," she says, "suppliers have focused on reducing the sugar and calories in flavored milks. In doing so, flavorists may need to replace the sweetness perception with sweetness enhancers for proper flavor delivery."

### **Ice cream dreams**

With fat levels as low as 0 to 4 grams per 8-oz. serving, flavored milk has taken less heat on that

front. But fat is flavor's friend, increasing perception of creamy notes and holding flavors on the palate. So, in a head-to-head showdown, chocolate ice cream, at roughly 10% to 14% fat, might have a flavor advantage over its milky cousin.

However, other elements hamper flavor expression in ice cream. "Ice cream is thicker," Cummings says, "slowing down flavor release." And the frozen temperature retards flavor perception, while also numbing the palate. "In general," Gribou says, "warmer temperatures allow for heightened perception of more volatile flavor components, like esters. Some of the nonvolatiles, such as sweetness, also increase in a refrigerated product like chocolate milk versus a frozen chocolate ice cream."

Matters of perception aside, our favorite ice cream flavors remain vanilla, chocolate and strawberry, with Neapolitan and cookies-and-cream close behind. Our choices "really haven't changed significantly over the years," Scott says, but what have changed are the standards by which consumers judge their quality and authenticity. "They're craving more characterizing flavors that drive the flavor experience," he says.

Global influences migrating to the ice cream counter include dulce de leche, which Scott thinks is "probably the most integrated" of the international flavors in the mainstream. "Profiles like green tea are also beginning to trend inward and garner more appreciation," he says. "Others include mango, the influence of coconut and even extreme new trends such as the influence of peppers, various milks like goat and sheep, florals like lavender, black sesame and mascarpone."

### **Flavor for the ages**

Lavender ice cream does seem extreme compared to plain vanilla. But it's no match for the wild profiles that occur naturally in some cheeses. Whether a stinky Brie or tangy feta, a cheese's flavor reflects the transformations of lactose, fat, casein and whey that take place during fermentation and aging.

It's hard to overstate just how important aging is to cheese flavor. A fresh mozzarella with very little or no aging will taste not unlike the milk it once was. According to Luis Jimenez-Maroto, sensory coordinator, Wisconsin Center for Dairy Research (WCDR), Madison, sponsored by the Dairy Research Institute, it might be "buttery and creamy from the milkfat, salty from the salt added during cheesemaking, slightly sweet from the lactose and slightly acidic from the pH drop generated by starter cultures that eat the lactose and produce lactic acid."

Allow that cheese to age and cultures start metabolizing proteins, yielding shorter peptides and amino acids that add a wealth of flavor all their own. "Depending on the cultures present," Jimenez-Maroto says, "we can get compounds like hydrogen sulfide and dimethyl sulfide that generate the sulfuric flavor of aged Cheddar, or a mixture of esters—ethyl benzoate, ethyl butyrate, etc.—that give off a fruity flavor like in Parmesan." Meanwhile, as bacterial enzymes cleave butyric, caproic, caprylic and capric acids from their glycerol backbones, these free fatty acids give us the "sharp, sweetish rancidity of a Romano," Jimenez-Maroto says.

Other flavor influencers include the type milk: "Various breeds of cow, sheep and goat have milk

fats with different proportions of free-fatty-acid chain lengths," says Dean Sommer, cheese and food technologist, WCDR. "This results in significantly different flavors in cheeses made from these milks, accounting for the 'goaty' and 'sheepy' notes often seen in cheeses made from milk of these animals."

Cultures and enzymes are other dramatic determinants of flavor through fermentation and molecular breakdown (such as proteolytic action) in aged cheeses like Cheddar, Swiss and Parmesan, as well as those with white or blue molds. In the case of washed-rind cheeses like Gruyère, Limburger, Comté and Beaufort, microbes present in the washing brine "grow and produce flavor in these cheeses as they ripen from the outside in," Sommer adds.

### **Damage control**

With so much going on, one wonders why we'd want to flavor cheese at all. One instance when we do, Sommer says, "is when we're using one variety for functionality—such as mozzarella in a pizza application—but want more flavor intensity than mozzarella typically has. In these cases we may add intensely flavored cheeses such as Romano, Parmesan or provolone for more flavor in the product." And, adds Jimenez-Maroto, "Other cheese products, like cheese powders, might be fortified with starter distillates to increase buttery notes, or short-chain fatty-acid blends to increase rancid and soapy notes, like with Romano or Asiago."

Sometimes we need to mask bitter products of unbalanced proteolysis. "The more cost-effective dairy components used in formulations, such as whey, milk concentrates and caseinate," also might be candidates for masking, Gribou says. "These ingredients often introduce off cardboard notes, stale dairy and lipid-oxidation products."

The high temperatures of processed-cheese manufacturing may drive off volatile, lower-molecular-weight chemicals, with the result that "much of the characterizing upfront portion of the cheese profile can be lost," Gribou says. Any Maillard reaction products that develop during heating will also introduce cooked notes—which may or may not be an asset.

When cheese processors reduce the fat in their products, the flavor effects can be striking. "Along with fat having its own flavor, it functions as a vehicle for a lot of fat-soluble flavor compounds," Jimenez-Maroto says. So while a full-fat medium-sharp Cheddar "will have slight buttery notes from the milkfat; a good balance of brothy and sulfur aromas, and will cover the mouth with a thin layer of fat that tells the brain the cheese is tasty and satisfying," a reduced-fat version might lack that buttery goodness and might even show a little bitterness from peptides that the milk fat would otherwise hide. "The mouth will not be covered with fat, either, which signals the brain that the cheese is not as filling as expected," he adds. Damage control can be as simple as adding small amounts of starter distillates for a buttery note, or "a compound to act as a vehicle for other flavors to compensate for the low-fat shortcomings," he says.

### **Saucy attitude**

Cheese often ends up in a sauce, where processing conditions and performance demands require a whole different approach to flavor. In the sauce medium, "it's essential to provide the richness

of the cream and butter as the backbone of the flavor you're developing," Gribou says. "Heavy cream, butter and Parmesan cheese flavors are basic in prepared alfredo sauces." For additional complexity and characterizing flavor, go with blends that deliver Parmesan and Romano attributes, she says. "The Parmesan flavor should provide the savory, nutty character in the sauce, and with the addition of the attributes from the Romano cheese flavor, the overall intensity will increase along with the lingering fatty acid character often found in prepared alfredo sauces."

Cummings notes that starch stabilizers can mask a sauce's flavor. "Increasing the acid for a tart profile will allow the flavor to come through with more impact." A little salt can also brighten a cheese sauce or dip.

As Jimenez-Maroto notes, "Strong flavors work well on cheeses that end up in dips. Lots of salty, rancid, piquant notes are usually good in a dip if you want the cheese flavor to come through."

Cummings recommends "process-proving" flavors under conditions similar to what they'll see during high-temperature processing, like UHT. Fortunately, today's flavors withstand these processes better than their predecessors. "If the flavor is designed to take into account reactions that occur during heating, volatile loss and other considerations," Gribou says, "any flavor form will be suitable."

Flavor companies keep building new tools to address these issues. "New encapsulation methods help protect flavor chemicals in harsh environments, such as baking applications," Gribou says. "Analytical techniques continue to improve to identify nonvolatile components, which make up a majority of any cheese profile." Proprietary software programs can even predict the partitioning of flavor components "to create a flavor that's balanced in the appropriate food matrix." So, even though flavoring dairy products remains complicated in theory, it appears to be getting more foolproof in practice.

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## **Slippery or Smoothie?**

Treading that liminal ground between ice cream, milk, yogurt and juice is the dairy-fruit smoothie. And though smoothies have been a genuine hit with consumers, they remain a slippery concept. "'Smoothie' has many different definitions in the U.S. marketplace and food landscape," says Paulette Haber, director of marketing communications and research, Virginia Dare, Brooklyn, NY. "The most common is 'a thick, creamy beverage composed of both fruit and dairy ingredients.'"

Citing research from her company's marketing team, Haber notes that the prototypical smoothie consumer is the adult female, usually a mom, and the most likely source for her smoothie is the

home blender, followed by fast-food restaurants. "Smoothies are most popular as a mid-afternoon or afterschool snack," Haber continues, "and the top eight ingredients commonly used to prepare smoothies are ice, fresh strawberries, fresh bananas, milk, frozen fruit, fresh blueberries, yogurt and fresh mangos."

The choice of ingredients reflects what Haber says are the most popular smoothie flavors: strawberry-banana, mixed berry, mango and "tropical."

"Flavors that consumers identify as not having tried but would be most interested in trying include apple caramel, blueberry cobbler, pomegranate, nectarine, green tea and strawberry kiwi," Haber adds. Any manufacturers ready to rise to the challenge?