# Taste and Flavor Innovations for Healthier Products

## How pharmaceutical technology is expanding the frontiers of taste ingredients

*A taste panel at Senomyx's San Diego headquarters; in categories such as fructose enhancers, the most promising samples will be evaluated via taste test following optimization.*

"It's pretty obvious that there's a large movement in the food industry relating to the health of [consumers'] diets—especially in the United States—which are loaded with sugar and salt," says David Linemeyer, vice president, biology, at San Diego-based Senomyx. "We know that there are medical problems that are clearly associated with consuming high concentrations of sugar and sodium," he adds, citing obesity, diabetes and hypertension. As a result, he says, "The food industry is more and more focused on decreasing the amount of sugar and sodium in its products. That plays into our technologies precisely in terms of being able to decrease the amounts of sugar and sodium in food without affecting the taste and flavor that the consumer desires in those products. We're not a traditional flavor company that's trying to develop a new cherry or watermelon flavor. We're looking to change the nutritional profile of products by reducing the amount of sugar and salt."

Both Linemeyer and Don Karanewsky, Senomyx's senior vice president and chief scientific officer, come to the world of taste and flavor by way of the pharmaceutical industry. Karanewsky, an organic chemist, spent nearly 30 years with organizations such as Bristol-Meyers Squib, GlaxoSmithKline, Novartis and some smaller biotech companies. Linemeyer, a biologist, spent much of the last three decades conducting pharmaceutical research for Merck & Co. Inc., Bayer and Metabasis Therapeutics. Combined, Linemeyer and Karanewsky's experience highlights expertise in the use of receptor-based assays for the screening, identification and optimization of compounds that interact with taste receptors in a way that enhances or diminishes their sensitivity.

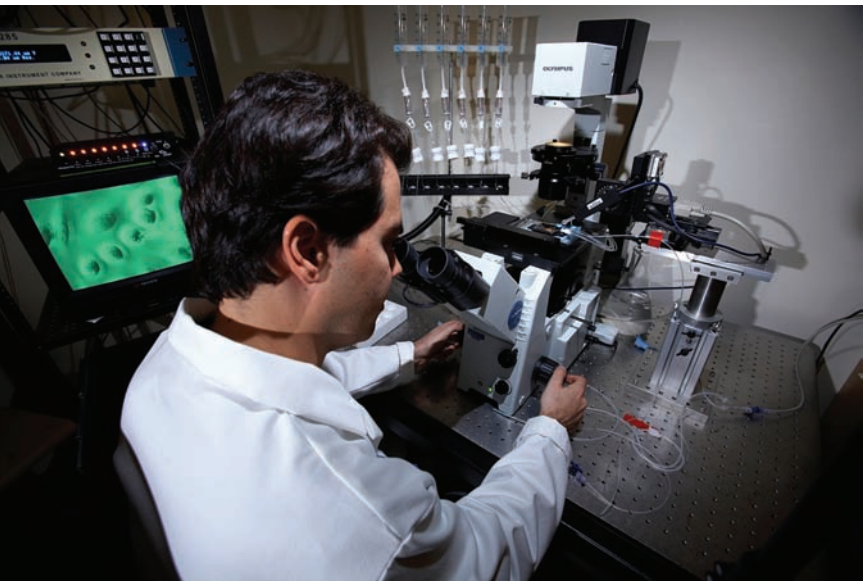
"It's very similar to the processes involved in discovery in the pharmaceutical arena," says Linemeyer. "The receptors that are involved in detecting and recognizing taste are very similar to the types of receptors that are used in pharmaceutical treatments."

The company's model of supporting health and wellness with taste technology recently net it $5.8 million in revenues for the third quarter 2010 (the most recent period on record as of press time), an increase of 40% year-over-year. Revenues for the first nine months of 2010 totaled $19.2 million, a gain of 80% compared to the same period 2009. As a result, the company has increased its revenue projections moving forward.

### Sweet Taste

The largest research effort at Senomyx falls under its Sweet Taste Program. One reason, says Linemeyer, is that each type of sweetener requires its own tailored enhancer: "It's not a one size fits all situation." He adds, "Also, there are a lot of different ways that flavors are introduced into the final food product. And there are many different characteristics of the flavor agents to consider when you do that. It's difficult to find one agent that would actually qualify in terms of all those different parameters."

The company's first major sweet enhancer was S2383, which boosts the perception of sucralose, the type of sweetener used in commercial products such as Splenda. "These [enhancer] compounds do not have a taste quality on their own," Karanewsky explains. "When you taste them in solution—they're used at very low concentrations—they impart no taste characteristics on their own." Under an exclusive worldwide agreement, Firmenich has begun commercializing flavors that include S2383. Per the agreement, Firmenich has exclusive global rights to market S2383 as both a standalone ingredient and as part of a flavor system in all food products, including beverages, cereal, dairy products, baked goods and confectionary.



*Senomyx's researchers are actively engaged in identifying and optimizing taste ingredients that could ultimately allow product manufacturers to decrease the amount of sugar and sodium in foods and beverages—without affecting the taste or flavor consumers desire.*



The company has also partnered with Firmenich on S6973, a sucrose enhancer. Under the aforementioned agreement, Firmenich may commercialize the material in nearly all food categories, some powdered beverages, and ready-to-drink milk, tea and coffee beverages.

"It allows you to significantly reduce the amount of added sugar in products," says Karanewsky. "It's not like replacing half the sugar in a product with an artificial sweetener." Instead, he says, "It just amplifies the taste of the sugar that is present. What you end up with is a product that tastes very much as if it had the full amount of sugar in it."

Karanewsky says that S6973 works by enabling the tongue's sweet receptors to respond to a lower concentration of sucrose. "It boosts the perceived sweetness of a dilute sucrose solution, making it taste like a solution with much higher amounts of sucrose," he says. "In doing so, formulators can make a relatively weak sucrose solution, or dilute sucrose solution, taste identical to one that has a much higher concentration of sucrose. Depending on the product application, we can reduce sugar by as much as 50% and still maintain the same taste quality of a sucrose-sweetened product." And, he adds, "By reducing the amount of sugar in a product by half, especially in a beverage, you pretty much halve the calories of a product." First sales of products containing S6973 should take place in 2011.

Meanwhile, says Karanewsky, "We continue to work on additional sucrose enhancers that have different physical properties to make them applicable to other product categories. An enhancer has to be used across a whole range of product categories with different qualities in terms of solubility and thermal conditions. Sucrose is used in a wide range of products, from baked goods to low pH beverages to neutral beverages. Baked goods, for example, are subject to high temperature for short periods of time."

*Boriruck Kitisin, principal food scientist, using a Hobart mixer in Senomyx's food science and technology department.*

Also under way, says Karanewsky, is Senomyx's pursuit of enhancers for fructose, particularly for carbonated beverages. "We have compounds that meet the criteria of providing a taste proof-of-concept," he says. "We're now looking to improve them in terms of the magnitude of the effect."

The company's latest announced partnership in the sweet category is PepsiCo, which is seeking sweet enhancers and natural sweeteners, primarily for carbonated beverages. Under the agreement, Senomyx received an upfront payment of $30 million from PepsiCo and is entitled to $32 million in committed research and development payments over the four-year research period.

## Salt Enhancers

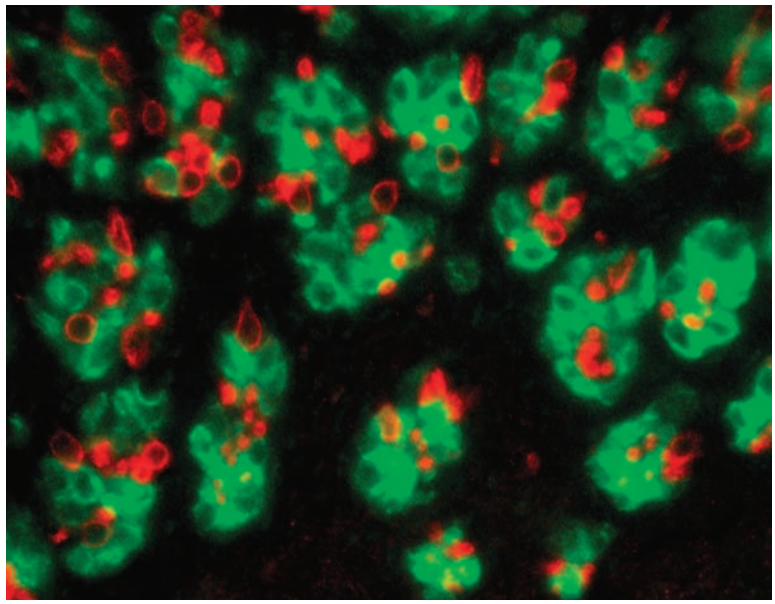
Another significant taste program at Senomyx addresses salt. The company notes that it has discovered taste bud proteins that may have activity that will allow it to identify salt taste enhancer compounds. If so, the ingredients could find use to reduce sodium in foods and beverages.

## Bitter Blockers

According to Karanewsky, Senomyx recently received GRAS regulatory determinations for two bitter blockers, S6821 and S7958, which will be employed by an unnamed collaborative partner. These compounds effectively block the tongue's bitter receptors, reducing bitter impressions caused by certain products. "These bitterness blockers have a lot of potential in improving the taste profile of ingredients that aren't particularly palatable," he notes. "For example, some companies are looking to improve the nutritional profiles of foods by adding hydrolyzed soy and whey protein. The limitation is that hydrolyzed proteins don't taste very good and often impart bitter taste characteristics to products. We're hoping that our bitter blockers can allow the use of higher levels of those proteins in products." In addition, Karanewsky says, "They block the bitterness of menthol, caffeine, cocoa and rebaudioside A."

## Cooling Compounds

Semomyx's cooling compound activities are interesting because the research doesn't involve a basic taste such as bitter or sweet. However, says Karanewsky, "It's something that lends itself well to the type of technology we've developed in terms of identifying new agents. One of our collaborators is very interested in finding new cooling agents that have better properties than the compounds that are currently marketed for that purpose." The compounds developed under this program will eventually find use in confectionery applications such as gum and oral care products like mouthwash. Senomyx recently approved a two-year extension of its development, commercialization and license agreement with Firmenich in the cooling agent category. The agents developed in this program will be used exclusively by Firmenich worldwide. Royalties will be paid to Senomyx based on sales of flavor systems that incorporate these compounds.



*Imaging of human sweet, bitter and umami taste cells.*

## Partnerships

Under its various programs, Senomyx has entered into partnerships with companies such as Nestlé, Ajinomoto, PepsiCo and Firmenich. Though the particulars of each partnership may vary, the key, according to Gwen Rosenberg, Senomyx's vice president of investor relations and corporate communications, is differentiation. "Part of the collaboration is that Senomyx's partners have exclusivity or co-exclusivity for the use of certain flavors that are discovered and developed under a specific program," she explains. "For example, they could have exclusive use of an enhancer in specified product categories marketed in defined territories. I think it is important to them to be able to distinguish their products from their competitors." In some cases, Senomyx may receive research funding from its partners. Compensation may also come from up-front payments, milestone payments, and/or royalties based on the sales of materials as single ingredients or products/flavor systems that include the ingredient in question.

## Natural Solutions

Beyond its current ingredient portfolio, Senomyx is pursuing natural materials to meet consumer demands for natural products. "Part of our collaboration with PepsiCo involves natural enhancers and natural high-potency sweeteners," says Karanewsky. "We have built internal capability over the last few years to extend our programs from artificial enhancers and flavor agents to natural equivalents for sweet enhancers of natural high-potency sweeteners like rebaudioside A. We have a good part of our research efforts now devoted to finding natural equivalents to the types of enhancers we've developed so far." Senomyx doesn't yet have a timeline set for the commercialization of such products. Karanewsky notes that the materials require assessment for viability and commercial scaling.

Rosenberg points out that the company is not starting from scratch with this next phase of research. "One thing that gives us an advantage … is that we have characterized the human sweet taste receptors. We already know a lot about them, how they function. We've developed assays with them. We're certainly further along than when Senomyx first started."