

# In the Future, Your Food Will Be Sweetened With Protein

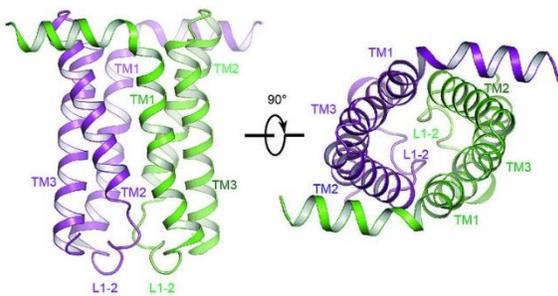
How a network of startups and scientists are moving to use cutting-edge tech to fight the obesity epidemic

by Boyd Farrow for Medium Future  
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When we wonder what our lives will be like in the future—if we'll be playing tennis against robots, say, or wearing self-driving jetpacks to commute—chances are few of us are imagining that we're going to be any skinnier. Almost 40 percent of Americans are now obese, with more than 35 percent of people in seven states being chronically overweight. To put this in context: In 1985, no state had an adult obesity rate higher than 15 percent. Globally, the World Health Organization says obesity has almost tripled since 1975.

Yet one pioneering Israeli startup believes that this tide could easily be reversed. In a modest lab located in a Tel Aviv suburb, scientists at food tech outfit Amai Proteins are creating protein molecules out of a rare tropical plant that can taste thousands of times sweeter than sugar. The company claims that by fermenting these proteins in microorganisms, such as yeast, it can produce a brand-new sugar substitute without the side effects of existing alternative sweeteners, some of which have been shown to be carcinogenic or cause weight gain.

“Sugar kills more people than gunpowder every year, but scientists tend to only focus on the diseases it causes,” says biochemist Ilan Samish, who formed Amai Proteins two years ago. “I am on a mission to cure the food. We are not making protein identical to proteins found in nature. We are redesigning the proteins.”



At the moment, Samish and his team are on a sort of sugar high themselves, having in January completed a wholly new protein that he excitedly calls “the world’s sweetest substance.” It is derived from the reengineered DNA of a plant found in a shady patch of Malaysia, the name of which Samish would not disclose, and is “by weight, 16,000 times as sweet as sugar.” A barely visible 0.375 milligrams of this sweet protein is equivalent to a teaspoon of sugar.

There are many compelling reasons why using such ultra-sweet proteins instead of sugar would be much healthier for us, Samish explains. “They bind to the sweet receptor on our taste buds but are digested in our upper GI tracts like every other protein. They don’t initiate blood sugar or insulin response. They don’t make us fat by changing the microbiome, the huge army of microbes in our guts, in the same way that sugar does.”

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Existing alternative sweeteners—whether artificial, like aspartame, or natural, like stevia-leaf extract—also carry health risks, according to Samish. All these sugar substitutes comprise “small molecules,” which essentially pass through the body after being digested by the liver and kidneys, sometimes causing harmful compounds or even triggering higher blood glucose levels. Moreover, some people who opt for zero-calorie sweeteners can still pile on the pounds because the presence of these small molecules among the microbiome disrupts their metabolism.

“The bottom line is that 99.99 percent of all proteins are healthy,” Samish says. “A regular-sized person should eat 56 grams of protein a day, according to U.S. guidelines. Most of us eat more than that, so a few milligrams more make no difference.”

Nearly everyone, he reckons, could enjoy protein-sweetened sodas, dairy products, and even premium chocolate bars without needing to worry about diabetes or obesity. Which is why Samish’s tiny startup is attracting the attention of food conglomerates from around the world. “Our silver bullet,” he says, “is we have produced something healthy, cheap, and actually tastes of sugar.”

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Although Samish points out that the alternative sweetener market is worth around \$9 billion a year—10 percent of the actual sugar market—he says his work with Amai is motivated more by his own uneasy relationship with sugar. Growing up, his twin sister always ate less food than he did, Samish recalls, but he was always thinner. “Basically, I grew up avoiding eating anything sweet because it would make her feel bad,” he says. “It would be hugely satisfying not just to help make society healthier, but to enable people to enjoy something without feeling guilty.”

Scientists have known about the existence of sweet proteins in some tropical plants since the 1970s. Thaumatin—found in the fleshy fruit of katemfe, a solitary plant that grows in heavily shaded parts of Nigeria and Sudan—is now used as a flavor enhancer in approximately 350 products, including low-calorie sweeteners. Large-scale production, however, has been impossible. Stubbornly resistant to agriculture, these plants can be harvested only by hand before they are shipped overseas for the protein to be extracted. Once processed, the stuff costs around \$1,000 a pound.

Another problem is that many sweet proteins are too unstable to be added to acidic liquids such as Coca-Cola or used in fat-saturated baked goods, which are produced using high temperatures. And most also have a bitter aftertaste, not unlike stevia.

After his postdoctoral research at the University of Pennsylvania with William DeGrado, the “father of computational protein design,” Samish realized that no one had ever tried to solve these particular problems with a high-tech method. By harnessing vast cloud computing power, he began mapping and modeling the complex structure and energetics of several sweet proteins without ever using the actual plants.

“Proteins are like a necklace of beads,” Samish explains. “The beads are the amino acids.” By changing the sequence of these acids out of a possible combination of 200 to the power of 20, Samish explains, he has created a “family” of sweet proteins. “Other firms are also working on developing sweet proteins, but we have managed to solve the problems of yield, stability, and taste.”

Amai ferments the lab-designed DNA in yeast. “It is just like brewing beer, only we end up with a pure white sweet protein powder,” Samish says. Because so little of it needs to be used to sweeten food, it effectively makes the substance virtually calorie-free, as well as cost-effective, he says. “I don’t need the fruit. I just need to see the protein’s structure on a computer, then I order the code.” The final product is usable in adherence with European food industry standards.

Samish is convinced that the entire food industry is on the brink of a real sugar revolution. “I didn’t leave academia to make a quick buck, but because I felt that we were on to something big here,” he says. Others are taking notice. Apart from the \$120,000 of cloud computing time Amai has received from Amazon and Google to power its resource-hungry protein designs, the company has banked NIS 3 million (\$800,000) from the Kitchen Hub, a local incubator owned by Israeli food and beverage company Strauss Group, which is partly owned by French multinational food giant Danone. Amai is now seeking to raise \$10 million in Series A funding in the first quarter of this year to finance the next stage of its business.

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Amai isn’t the only Israeli startup developing innovative alternative sweeteners. Of the country’s 270 food tech startups, at least a dozen are working on sugar replacements—and all have big ambitions. Rehovot-based Unavoo Food Technologies, for instance, has created a product called Heylo, which laces a soluble dietary fiber from the acacia tree with stevia. It has been trialed in beverages, ketchup, peanut butter, and dairy products. The company’s first and main target market will be the United States, where it recently opened a subsidiary.

Another startup, AIC Foods, in nearby Ramat Gan, actually uses small amounts of regular sugar in its chocolates and ice creams but adds a patent-pending blend that lowers their glycemic index. The company was founded by Ran Hirsch, whose daughter was diagnosed with diabetes, and Mariela Glandt, the renowned endocrinologist who treated her at Tel Aviv’s Glandt Center for Diabetes Care.

“We do not put anything artificial, including sweeteners, in our food,” Hirsch says. “The formulation is where our expertise lies.” They are currently talking to companies in North America, Europe, and the Far East that want to co-manufacture, and they hope to release their first commercial products in six months. Hirsch says AIC has been developing healthier pizza and pasta dishes that contain far less sugar than typical commercially produced fare and has received interest from noodle companies in China and tortilla makers in Latin America. “The secret is to make something delicious,” Hirsch says. “Nobody wants healthy. They want delicious.”

It is no coincidence that Israel, already a world leader in both food science and diabetes research, is responsible for so many breakthroughs in sugar replacement. “Some of the world’s leading food scientists and human nutrition experts are located there, and the research community is known worldwide for pushing innovation forward,” notes Kim Kidwell, dean of the College of Agricultural, Consumer, and Environmental Sciences at the University of Illinois. “In a country where water availability dictates possibilities in many realms, it makes tremendous sense to me that some of the greatest breakthroughs in food innovation are being made there.”

The other thing that sets Israel apart is the high number of joint ventures between those working in cutting-edge technology, academia, and research institutions—such as the Weizmann Institute and the Hebrew University—and in the business sector. Masha Niv, vice dean of the Hebrew University’s faculty of agriculture, food, and environment, says the country’s culture of interdisciplinary studies means many of its top brains often are approaching the problem from completely fresh perspectives.

Last year, Samish and Niv founded a forum to boost collaboration between Israeli academics and food industry leaders in the field of healthy sugar reduction. Called the Sweet Science Forum, it is designed to share research and brainstorm solutions in subjects like sweet perception, molecular mechanisms of sweetness, and sensory analysis. Members include scientists from the Technion, the Hebrew University, and the Volcani Institute (an Israeli agricultural research center), as well as food industry giants such as Strauss and Tnuva, which is owned by China’s Bright Food.

The Hebrew University recently collaborated with another ambitious startup, Better Juice, on developing a technology that converts up to 80 percent of natural sugars found in orange juice into dietary fibers. Regular juices tend to be fattening because natural sugars like fructose, glucose, and sucrose are quickly converted to fat if sufficient energy is not burned off. Like Amai, Better Juice is also backed by the Kitchen Hub.

Similarly, Samish says he can turn to another Kitchen Hub-backed startup, called DouxMatok, if he should need to “bulk up” products. DouxMatok adds an inert mineral carrier to sugar so food can contain 40 percent less sugar while delivering the same sensation on the tongue. As Samish points out, without a bulking agent, a pot of protein-sweetened yogurt could contain barely a mouthful of yogurt. Last summer, DouxMatok struck a partnership with Europe’s largest sugar producer, Südzucker, and a major U.S. deal is believed to be in the works.

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For Samish and his team, the next stage is narrowing down the hundreds of thousands of sweet proteins they have created to one that is deemed good enough to be manufactured on a large scale. So far, Amai has experimented with a range of beverages, yogurts, and protein shakes with varying degrees of success. “When we replaced up to 60 percent of the sweetener with our protein in lemon and orange sodas, 90 percent of people could not tell the difference,” Samish says. “When the drink contained more than 60 percent, they noticed, so it still needs more work. We don’t want to taste like a diet drink. We want to taste like sugar.”

“It is a very new product, and there needs to be some adjustments, but they are definitely on track. I would say that in a couple of years we will see sweet proteins used in drinks.”

Significantly, Amai is currently in advanced talks with both Danone and SodaStream International, the maker of consumer carbonated drinks machines, over the testing of sweet proteins in unspecified products. Tel Aviv–headquartered SodaStream, which has successfully branded its fizzy drinks as a healthy alternative to shop-bought sodas, was acquired by PepsiCo last April for \$3.2 billion.

“What Amai is doing is very exciting,” says Shmuel Marko, who heads up the syrups R&D department at SodaStream. “It is a very new product, and there needs to be some adjustments, but they are definitely on track. I would say that in a couple of years we will see sweet proteins used in drinks.”

By then, Samish hopes to have scaled up production of sports and energy drinks, diet drinks, and flavored beers. “Millennials like beer that is tasty and sweet but without additional calories,” he asserts. He envisages that Amai will then expand into so-called functional foods, which promise health benefits beyond basic nutrition, such as meals formulated specifically for diabetics, and then finally the main consumer market—“sauces, ketchup, everything else.” Based on the recent funnel-to-fork journey of lab-made meat, Samish reckons his sweet proteins are three years away from regulatory approval.

“My aim is not to get into the whole-food and premium market, but to get cheap and healthy product into the lower-priced stores,” he insists. “I want to make a real impact on what is a global problem.”

Samish says he is optimistic about his mission because the food industry as a whole is desperate for healthier, low-cost sugar alternatives amid growing public awareness of obesity, diabetes, and cardiovascular issues, not to mention looming or threatened regulations. “In this context, I believe that in 50 years, diseases such as diabetes will be far less common than they are today.”

“Everything comes down to the taste though,” Samish adds, “and we are very close to getting that just right.”

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