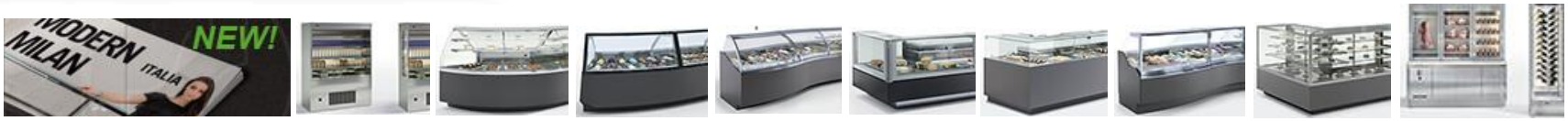
Volume 117 August 1, 2022

OSCARTEK

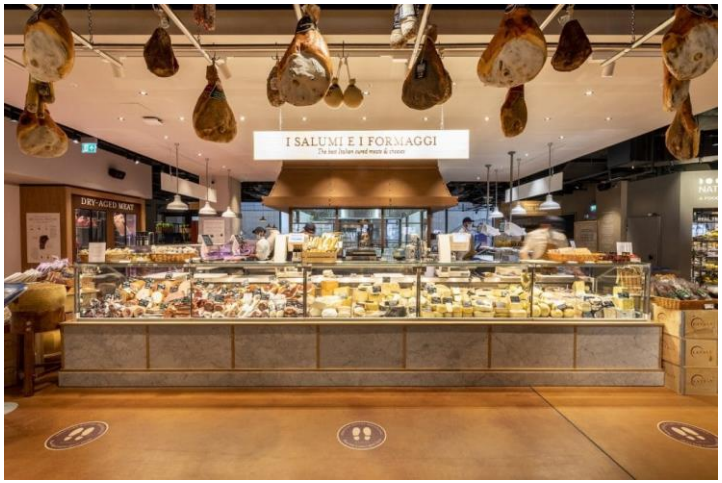
The Journal

Can food crops grow in the DARK?



Epic Italian food hall 'Eataly' opens Bay Area's first: vast temple of Italian food and drink.

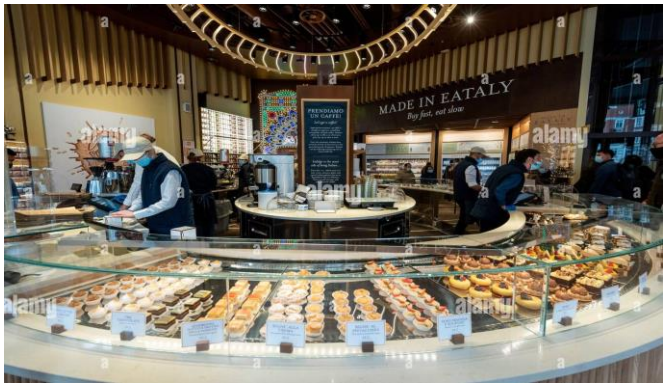
San Francisco CA, August 1st, 2022; After years of anticipation, Eataly is finally bringing a 45,000-square-foot, three-story Italian food haven to the Bay Area. The company Eataly, which was born in Torino, Italy in 2010, now runs 40 outlets worldwide. In California, the first West Coast location opened in Los Angeles in 2017, also at a Westfield mall. Today Eataly is busy hiring for 300 jobs at the new Eataly, including a fishmonger, butchers, chefs and a mozzarella maker. Other locations boast meat,fish and cheese counters; bakeries; gelato stands; and retail shelves stocked with everything from Italian truffles to jarred ragu sauce from Bologna, Italy. Eataly also plans to sell local products at the Bay Area store, said Raffaele Piarulli, head of Eataly North America.



Oscartek cases on display throughout the hall

Eataly spent years looking for the right home for the company's first Bay Area location, Piarulli said, but once Westfield became "a possibility, there were no other contenders."

He lauded the South Bay mall's recent $1.1 billion redevelopment, which has helped draw in top restaurants, from burger cult favorite Shake Shack to Korean barbecue chain Baekjong. In 2020 alone, Westfield opened 42 restaurants and stores.



Constanza Hevia H./Special to The Chronicle

Eataly, where gold-gleaming pizza ovens burn at 900 degrees, cheese is made fresh daily in a mozzarella lab and an entire floor is devoted to Italian wines.

In other words, it's Italian food heaven, and it's finally here. The epic, three-story Italian food hall's first Bay Area location opens at the Westfield Valley Fair mall in San Jose at 5 p.m. on June 16. If the yearslong anticipation is any indication, there will likely be throngs of people waiting in line. With two restaurants, a cafe, gelato shop, bakery, butcher, seafood counter and market stocked with thousands of imported Italian goods, there is no other food hall like it in Northern California.

This marks the eighth U.S. location and 41st location worldwide for Eataly. There are seven places to grab a meal or a snack.

The top floor is home to two of Eataly's standard restaurants. Head to La Pizza & La Pasta for Neopolitan pizza that cooks in 90 seconds in those massive wood-burning ovens as well as fresh pasta.

The menu hasn't been finalized, but it will be similar to other locations. Expect snacks like arancini and roasted peppers with house-made burrata; and pizzas topped with buffalo mozzarella, 18-month aged Parmigiano-Reggiano and prosciutto. Many kinds of pasta are made fresh at Eataly, but the kitchen also uses dried pasta from Gragnano, a small coastal town in the Campania region known as Italy's dried pasta capital. The 210-seat modern restaurant has its own outdoor terrace. On the other side is Terra, where everything is cooked on a wood-burning grill: tomatoes, steak, broccolini, bigeye tuna. Don't miss the grilled Pugliese -style skewers, like a meaty combination of pork, mortadella and provolone

The 180-seat restaurant has an indoor-outdoor feel thanks to hanging plants and floor-to-ceiling windows that open onto a rooftop terrace. (There's also an outdoor lounge here with its own menu, geared toward grabbing a casual drink and snack.)

Down on the first floor are Eataly's more casual food options. Dino Borri, Eataly's global vice president of brand partnerships, said the company wants this area to evoke the feel of an Italian piazza. Grab an espresso from the coffee bar (Eataly uses Italian Lavazza beans) and a cannoli that's filled to order. A gelato counter will eventually boast as many as 20 flavors, made fresh daily with Straus Family Creamery milk, Italian pistachios and local produce like strawberries from Watsonville's Tomatero Farm. Or sip on a glass of Italian wine with slices of Roman-style pizza dolloped with burrata. There's indoor and outdoor seating. A market is stocked with thousands of specialty Italian products, many hard to find in the U.S.

For food obsessives, Eataly's third-floor market might be the most exciting draw. Shelves are packed with everything you need to make an Italian feast at home: regional dried pastas, tinned fish, sauces, an entire wall of olive oil, amaretti cookies. Many of the products used in the restaurant kitchens are sold here, from the prized Gragnano pasta to jarred tomatoes grown on a farm in southern Italy. (You can re-create a La Pizza & La Pasta pasta dish at home thanks to the same fresh pasta and pints of sauces sold

here.) A bakery churns out loaves nearly 24 hours a day using a 50-year-old mother yeast from Italy and stone-ground flour.

Fridges are stocked with an astounding variety of imported cheeses and cured meats. You'll find 10 kinds of Parmigiano-Reggiano, more than 40 kinds of Italian salumi and prosciutto from all five DOPs (Denominazione d'Origine Protetta, or protected designation of origin). Peek into the glass-walled cheese lab to watch employees make mozzarella, burrata and stracciatella (the gooey soft insides of burrata) for the market and restaurants.

Good news for people who live farther away or don't want to wait in line: Eataly will offer grocery delivery as far north as South San Francisco. Representatives said they hope to see "robust" delivery business at this location in particular. For the first time at Eataly, an entire floor is devoted to wine.

Shelves stocked with over 1,200 wine labels stretch to the ceiling inside Eataly's wine shop on the second floor. Everything is imported from Italy, from small-production sparkling wine to Lambrusco and a wide selection of Barolo. Bottles range from $20 all the way up to $1,000 for rare wines stored in a temperature-controlled room. There's also a small selection of liquors — grappa, amaro, limoncello — and local beers.

Eataly will offer daily wine tastings. Best of all, customers can order a glass of wine and bring it upstairs to sip while they grocery shop. While this is an Italian food mecca, there's also an emphasis on Bay Area products.

Borri said Eataly was drawn to the Bay Area in particular because of its "wealth of food biodiversity." When the company can't import something from Italy, it will fill the gaps with local goods. The meat counter is stocked by Oakland's Cream Co. Meats — expect everything from marinated, spatchcocked chickens to pricey A5 Wagyu beef — and a seafood counter will sell local spot prawns and Dungeness crab. Cheeses from Point Reyes Farmstead Cheese Co., Cowgirl Creamery and Laura Chenel share space in the fridges with Italian options. A small produce section will sell vegetables from Bay Area farms like Spade & Plow in Gilroy.

Eataly. Opening 5 p.m. June 16. See website for hours for each section. Westfield Valley Fair, 2855 Stevens Creek Blvd., San Jose. eataly.com/us_en/stores/silicon-valley

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Can food crops grow in the dark?

Scientists are working out how. Experiments suggest that it might become possible to nourish plants without photosynthesis—a tool that could one day help feed astronauts and a crowded planet

BY MADELEINE STONE PUBLISHED AUGUST 2, 2022

Science fiction stories have imagined future people living in underground cities on Mars, in hollowed-out asteroids, and in free-floating space stations far from the sun. But if humans are ever to survive in any of those harsh and alien environments, they will need ways to grow food using limited resources—and photosynthesis, the wildly successful yet energy-inefficient process by which plants turn sunlight into sugar, might not cut it.

Now, some scientists are wondering whether it's possible to produce food more efficiently by skipping photosynthesis altogether, and growing plants in the dark.

The idea sounds as science fictional as cities on Mars. But a team of researchers has taken a first step toward realizing it with a study published in Nature Food in June. The research shows it is possible to grow algae, edible yeast, and mushroom-producing fungi in the dark by nourishing them with a carbon-based compound called acetate that didn't originate from plants, but instead was manufactured using solar electricity. The scientists are hopeful that this method, a type of "artificial photosynthesis," could unlock new ways to produce food using less physical space and energy than traditional agriculture—including, perhaps, crops that can grow in the dark.

While other experts are skeptical that it will ever be possible to redesign plant biology so radically, they are excited by the technology the researchers have invented and the team's out-of-the-box idea about how to make food production more efficient.

"We have to figure out ways to grow plants more efficiently," says study co-author Feng Jiao, a professor of chemical and bio-molecular engineering at the University of Delaware. "Which [solution] is best? I think the beauty of science is that we explore all the possibilities."

More efficient than nature

With the exception of a few extreme environments such as deep-sea hot springs—which are sustained by the chemical energy of hydrogen sulfide bubbling out of cracks in the seafloor—all life on Earth is fueled by the sun. Even apex predators like tigers and sharks are part of complex food webs that trace back to plants, and in the oceans, tiny green algae. These so-called primary producers have a biological superpower: the ability to create organic carbon from carbon dioxide via photosynthesis, a biochemical process powered by sunlight. The researchers found that several kinds of mushroom-producing fungi (the white in these images) could grow using acetate from the solar-power electrolyzer as their sole source of carbon and energy. Normally such fungi depend on organic carbon produced by p...Read More

PHOTOGRAPH COURTESY ROBERT JINKERSON

But while photosynthesis is essential to life as we know it, it's not terribly efficient: Only about one percent of the sunlight that falls on plants is actually captured and used to make organic carbon. That inefficiency will pose a challenge if humans ever want to establish a self-sustaining presence in space, where it will be vital to produce food using as few resources as possible.

It's also a problem on Earth today as the human population grows, placing pressure on farmers to squeeze more calories out of the same land.

Some scientists believe the solution is genetically engineering crops to photosynthesize more efficiently. The researchers behind the new study are proposing something more unusual: Replacing biological photosynthesis with a partly artificial process for turning sunlight into food. Their process is a version of artificial photosynthesis, a term that has been around for years and encompasses various approaches to converting sunlight, water, and CO_2 into liquid fuels and chemicals like formate, methanol, and hydrogen. The researchers behind the new study say their work represents the been paired with an attempt to grow common food-producing organisms. Their system is based on electrolysis, or using an electrical current to drive chemical reactions within a device called an electrolyzer. In their recent study, the researchers created a two-step, solar-powered electrolyzer system that converts carbon dioxide and water into oxygen and acetate, a simple carbon-based compound.

The authors then fed this acetate to Chlamydomonas reinhardtii, a photosynthetic green alga. They also fed acetate to nutritional yeast and to mushroom-producing fungi—which don't photosynthesize themselves but ordinarily require organic carbon made by plants to grow. A kind of algae called Chlamydomonas, which normally requires sunlight to power photosynthesis, grew well in the dark, greening a flask that contained acetate (right). The control flask (left) contained no acetate. All of these organisms were able to take up the acetate and grow in the dark—independent of sunlight or photosynthetically derived carbon.

Compared with photosynthesis, the process was surprisingly efficient. Using artificial photosynthesis, green algae could convert solar energy into biomass about four times as efficiently as crops do using biological photosynthesis. Yeast grown using this process were almost 18 times more energy efficient than crops.

"This is one of the key advantages of using artificial pathways versus nature's pathways," Jiao says.

Growing crops in the dark?
Scientists already knew that the alga C. reinhardtii can grow on acetate in the dark—the organism is a mixotroph, meaning it can switch back and forth between making its own food photosynthetically or eating organic carbon produced by other plants. But according to senior study author Robert Jinkerson of the University of California, Riverside, this is the first time C. reinhardtii was grown on acetate that didn't come from recent photosynthesis or from petroleum products, which are the fossil remains of ancient photosynthesis. That's significant.

"This is the first time any photosynthetic organism, like algae or a plant, have grown independent of photosynthesis since they evolved," Jinkerson says. "It's completely decoupled." Having grown algae without photosynthesis, the researchers turned to a more

difficult question: Could they also grow crop plants? Lettuce plants could benefit from acetate—but only up to a point. They still require sunlight to grow. Developing crops that can grow in the dark remains a great technical challenge that may require genetic engineering.

Their initial results were encouraging. In the dark, the researchers grew lettuce tissue in a liquid suspension containing acetate, confirming that it can take up and metabolize an externally supplied carbon source.

And when they grew whole lettuce plants in the light (as well as rice, canola, tomato, and several other crop species), but fed them supplemental acetate, they found that the plants incorporated acetate into their tissue. Acetate marked with a heavy isotope of carbon, called carbon-13, could be traced into both amino acids and sugars, suggesting plants can use it to support a variety of metabolic processes.

However, the study did not show that whole plants can be grown entirely on acetate without access to sunlight—in fact, the researchers' experiments with lettuce indicated that too much acetate actually inhibits plant growth. Jinkerson says his lab is currently working on genetically engineering and breeding plants to be more tolerant to acetate. That will be necessary for the team's artificial photosynthesis method to support plant growth and food production in a significant way.

Emma Kovak, a food and agriculture analyst at the Breakthrough Institute, says the authors' results represent a "first step toward potentially using acetate to help feed plants for indoor production." That could reduce the energy needed to run indoor farms if it allows growers to reduce indoor light levels. But "massive progress would be necessary," Kovak says, to enable plants to grow robustly using acetate even under low-light conditions. Evan Groover, a PhD candidate in synthetic biology at the University of California, Berkeley, whose research focuses on genetically engineering plants to improve photosynthesis, agrees. The study "shows plants can uptake acetate, but that isn't evidence of them being able to really thrive on that or meaningfully synthesize food, fuel, or medicine," Groover says. Accomplishing the latter, he says, would require "completely reprogramming plants." At the same time, Groover says he found the authors' paper "exhilarating." "It shows us ways in which we might be able to capture light and carbon in strange, non-terrestrial environments, or environments where you can't do traditional farming," he says.

Food for deep space

An extraterrestrial environment might be where the researchers' technology is first applied. The researchers submitted their artificial photosynthesis concept to NASA's Deep Space Food Challenge, which awards prize money and recognition to groups with innovative ideas for feeding astronauts on long-term space missions. Last fall, the team's concept was named one of 18 U.S.-based Phase 1 winners. In Phase 2, those teams are required to build a prototype that actually produces food. Winners will be announced next year.

Winning the competition is no guarantee that a novel food production tech will be flown on a future space mission. Many technical details would need to be worked out first, says Lynn Rothschild, a senior research scientist at NASA's Ames Research Center who wasn't involved with the new study. Weight is a key consideration—and artificial photosynthesis would likely require hauling new equipment, including additional solar panels and electrolyzers, into space.

But Rothschild says it's worth keeping an open mind about how any efforts to redesign a fundamental biological process like photosynthesis could be applied, in space or on Earth: "The payoff may be something we haven't imagined yet."