



DAN WAGNER

FUTURE FEAST

Even the meat and potatoes are being reinvented: the meat could come from a test tube, and the potatoes could ward off cholera. **By Jim Kling**

SNEEZING GENTLY, you ease open the refrigerator door to take stock after returning to town from your summer home. The situation isn't so grim after all: there's that romaine lettuce you bought six months ago, still looking fresh and crisp. A chunk of Parmesan, picked up—what year is this again? And down on the bottom shelf: vegetables of various vintages and, there it is, that nice piece of cooked, shrink-wrapped synthetic chicken. It has been in your refrigerator longer than some of your neckties have been in your closet. Just as you realize that the scratchiness in the back of your throat is not going away, you come across a little bottle of antiviral salad dressing. That clinches it. Chicken Caesar salad it is.

Although that scenario may sound a little strange, tomorrow's

Blue food? Purple whatsits? Not likely. According to one successful purveyor of engineered foods, edibles with characteristics that deviate radically from current preferences won't catch on with consumers.

world of high-tech foods would most likely seem as fantastic to us as microwaves, frozen meals and today's wide selection of produce would have appeared to a cook just 50 years ago, let alone 100. Many of the details of how food will taste and look, and how it will be packaged and prepared, will depend on that most elusive of intangibles, consumer tastes and preferences. Nevertheless, several trends seem to be gathering momentum, offering glimpses of what and how we might be eating early in the next century.

One is the explosive growth lately in sales of dietary supplements and the advent of so-called functional foods, which contain additives that confer physiological benefits beyond simple nutrition. In addition, tasty new forms of protein—including steaks and fillets grown in chambers rather than as part of an animal—as well as packaging that lets produce breathe and treatments that kill harmful bacteria with radiation or pressure are all likely to be a part of the 21st-century dinner table.

SUPERCHARGED FOOD

One of the most remarkable phenomena in nutrition in recent years is the rise of dietary supplements and, in particular, of “sports supplements” aimed at weight lifters and other physically active people. Last year Americans spent about \$13.7 billion on dietary supplements, according to Grant Ferrier, editor of the *Nutrition Business Journal* in San Diego. About \$800 million of that total was spent on sports supplements, not including sports nutrition bars and electrolyte replacement drinks, Ferrier adds. The category barely existed a decade ago.

Such supplements could be just the first entries in a burgeoning market for supercharged food. “Most of the sports supplements are designed to produce benefits centered on control of body composition and energy,” says A. Scott Connelly, chairman and founder of Met-Rx Engineered Nutrition in Irvine, Calif. “People are realizing that the simple calorie theory of body fat control is hopelessly inadequate. For example, supplementing regular dietary intake with lean protein assists the body in burning fat,” he maintains.

One researcher is stimulating muscle cells in hopes of growing a filet mignon.

Connelly further notes that many staple foods such as rice and potatoes are poor sources of vitamins, minerals and other nutrients. Although nutritional supplement companies have long recognized this problem and marketed daily multivitamins and minerals to meet it, “I can tell you as a doctor that human beings don’t like to take pills,” he insists. “Probably less than 25 percent of people with high blood pressure comply with their prescription. Increasing nutrient density [of traditional foods] has to be a primary goal.”

As an example, Connelly cites pizza, “the nutritional Antichrist.” Met-Rx’s nutritionists have reengineered the humble pizza, the quintessential food for the masses. Each nine-inch pie has 650 calories—rather fewer than a conventional pizza that size would have. Moreover, the enhanced slice contains 75 grams of a high-quality protein—about four times more than usual. It also has 160 percent of the recommended daily allowance of calcium and 300 percent more lycopene. This plant pigment, which gives the tomato its red color, is also an antioxidant that has been linked in some studies to reduced incidence of heart disease and prostate cancer in men. The lycopene comes from a variety of tomato genetically engineered to produce considerably more of the molecule than a normal tomato does.

Where might it all lead? If you are waiting for a nutrient-packed food pill, a favorite of 1950s science fiction, you will be disappointed. Although military researchers are working on a high-density daily ration about the size of a deck of cards [see “What the Well-Dressed Warrior Will Wear,” on page 74], such a product is not likely to make its way into supermarkets. According to Con-

nelly, food will have to be “in sync with current taste and texture preferences. We won’t be successful in trying to get people to abandon their tastes for sweets and fats.”

IMMUNITY-BOOSTING PRODUCE

Another piece of evidence that the age of high-tech foods has arrived was the introduction last May of the margarine Benecol. Its makers say that eaten regularly in sufficient quantities, the product’s plant stanol esters can reduce the risk of heart disease by lowering levels of potentially harmful, low-density lipoproteins and increasing levels of healthy, high-density lipoproteins. The margarine is an example of a functional food or “nutraceutical,” whose additives provide one or more specific health benefits beyond simple nutrition.

Such foodstuffs could be the basis of an industry raking in \$34 billion by the year 2020, Ferrier states. Indeed, they are already carving out a sizable niche in Japan, he adds. Cutting cholesterol would only be the beginning; experts foresee products that would do anything from boosting your immune system to fighting seasonal allergies. For the seriously overweight, for example, there will be foods containing glucagon, a chemical that causes some people to feel full after eating modestly.

Suppose your doctor tells you, 15 years from now, that you’ve got a mild form of diabetes. Rather than closely monitoring your food intake and blood sugar levels, as you would probably have to do today, you might be able to find everything you

need to stay healthy in your local supermarket’s health food section. No, not the dreaded row lined with organic granola and sprouts but rather an aisle with foods containing additives that, to continue our example, regulate insulin activity and keep your blood sugar under control.

According to John P. Troup, head of nutrition research at the consumer health division of Novartis in Nyon, Switzerland, to produce an effective functional food scientists must “identify the mechanism in the body that is causing some response.” That means identifying the individual proteins that carry out the process and then designing a molecule to enhance or discourage the response. Once made, such molecules could be used as food additives.

These foods won’t be limited to a prescription aisle. Many common fruits or vegetables could be genetically engineered to produce vaccines for common childhood diseases. In fact, researchers at Loma Linda University School of Medicine have already genetically engineered potatoes to produce trace amounts of a cholera toxin that could immunize the diner, helping his or her system to resist cholera bacteria.

Instead of having to see a nurse to get a winter flu shot, you might be able to get immunized courtesy of your local grocery store. There, some visionaries predict, you will find prepared foods that contain a harmless component of the flu virus that activates your immune system to protect you from illness.

“More and more, the supermarket is going to become a health care provider store, rather than just a place you buy your food,” de-

MARK HAVEN



In a laboratory in Bay Shore, N.Y., researchers led by M. Aaron Benjaminson (above) are sustaining fish muscle cells and even growing modest amounts of new muscle cell components outside of a fish. The dark streak in the inset image is a tiny sample of fish muscle; it is surrounded by fibroblast cells, a major component of connective tissue. Ultimately, the work could lead to a synthetic fish fillet sandwich.



M. AARON BENJAMINSON

al textures. Some nutritionists see fish as the protein staple of the future. But Irene Chalmers, a food writer and professor at the Culinary Institute of America in Hyde Park, N.Y., is betting on soy. "It can be made into anything; any taste, any texture—crunchy or bland or squishy or slimy. It's going to be an enormous tool," she maintains.

Those of you who have tried tofu-based mayonnaises or hot dogs are probably wrinkling your noses. But good news is on the horizon, says Dana Jacobi, author of *The Natural Kitchen: Soy!* (Prima Publishing, 1996): "The Food and Drug Administration is expected to rule by this fall that foods containing at least 6.25 grams of soy protein in a serving can be labeled as helping to reduce the risk of heart disease"—a development she believes "will give large food companies incentive to play with soy."

And when corporate America turns its attention to soy, who knows what might happen. As a sign of good things

to come, Jacobi cites a new soy yogurt. In the past, the concoction earned a reputation as a gruesome substitute for the real thing, but the new product might change some minds, in Jacobi's view. "One company sent me some samples this year," she says, "and I sent them to a group of people without telling them it was soy. They called back asking where they could buy some."

As for animal protein, M. Aaron Benjaminson has a dream: producing it without the animal. Benjaminson, a researcher based in Selden, N.Y., has contracted with the National Aeronautics and Space Administration to develop systems for growing food for astronauts. While working on a system to grow edible mushrooms from human waste, "it occurred to me that not all astronauts will want to be vegetarians," he recalls (to say nothing of eating those mushrooms). A chicken coop in the cargo bay was obviously out of the question, so he came up with another idea: growing animal skeletal muscle tissue—a fillet or steak, in other words—in small chambers.

Basically, Benjaminson hopes to grow the muscle cells by stimulating them electrically, mechanically, hormonally and nutritionally. With enough tinkering, he thinks that within 10 years he will be able to grow something that has the consistency and taste of filet mignon. So far he has worked mainly with fish muscle cells and has had some limited success in producing a tiny mass of tissue that looks and smells like a fish fillet. Ultimately, he believes that such a technique could produce boneless chicken breasts for a fraction of the cost of a commercial chicken farm, without the salmonella and other harmful organisms that exist on supermarket poultry.

Clearly, in a world where a steak might come from a cow or a test tube and a head cold might be treated with a pill or a salad

clares Theodore P. Labuza, a professor of food science and engineering at the University of Minnesota. "These products are going to be put out in the produce section," he says, adding that "there's going to be a time when consumers are confused—are they buying food or a drug?"

Although food will change, our nutritional requirements will not. Humans will always need protein, the stuff of our muscles, organs and other tissues. Chicken, beef and pork could continue to be our main sources, but many experts foresee a growing market share for others.

Protein powders, for example, are among the big sellers in the previously mentioned sports supplement category. Whey protein isolate has become popular in recent years, thanks to greatly improved methods of manufacture. Basically, whey is what remains of milk when its other main solid components, fat and casein, are coagulated into cheese curd. It was essentially a waste product of cheese making until someone noticed that it was extraordinarily high in protein and extremely low in fat and in lactose, which some people find irritating to the stomach.

Runners, weight lifters and other fitness buffs are increasingly turning to whey protein isolate because it has a very high biological value, meaning that a relatively large proportion of the protein is retained in the body for a given amount absorbed. On a scale in which egg whites are arbitrarily assigned a biological value of 100, the figure for whey protein ranges from 110 to 159—higher than any whole food and much higher than beef, which has a value of 80.

SOY: IT'S WHAT'S FOR DINNER

The advantages of powders notwithstanding, it is hard to imagine most people doing without protein with more tradition-

dressing, the consumer is going to need a little more help. Fortunately, grocery stores are becoming more interactive, with help not only for the confused but also for the harried.

Already, for example, cooking demonstrations show off an increasing array of ready-to-eat meals. "Supermarkets will probably become the largest employer of chefs," says Chalmers of the Culinary Institute, one of the top training grounds for chefs in the U.S. She also believes that on-line grocery stores will be a big hit—with food delivered not via shopping cart and the trunk of the car but by overnight express. In fact, an experimental refrigerator has already been built with internal bar code readers and other systems that sense what staples are running low and automatically order them over the Internet [see "Living in Technology," on page 84].

On the other hand, our ravenous, overworked descendants returning from a hard day at the office may prefer to buy premade meals at drive-in windows, as more and more of us do today. "The fastest-growing dining environment for Americans is the front seat of their car," says Met-Rx chairman Connelly.

KEEPING IT FRESH

It is unlikely that on the shelves of tomorrow's high-tech, user-friendly grocery stores the tastier, healthier wares will be offered in the same old stifling packaging and wrappings used today. Take romaine lettuce. We've all seen its mysterious transformation: from a crisp, light delight to the taste buds to a repulsive sack of foul, brown goo after a couple of weeks in a standard plastic bag. Not so in the future, Labuza says.

The trouble with storing a head of lettuce in a garden-variety plastic bag is that the lettuce is still alive, taking in oxygen from its surroundings and metabolizing it. In short order, the supply runs out. "When the oxygen level dips below a certain level, [the lettuce dies and] begins to rot," Labuza explains.

Long-term preservation depends in part on maintaining the oxygen level of the bag at an optimum level—lettuce stays crisp in an atmosphere of about 3 percent oxygen. The goal for the plastics industry is to produce a plastic bag that takes in oxygen ("respires") at precisely the same rate that the vegetable or fruit does. Polymer scientists have already made some progress in this area. River Ranch Fresh Foods in Salinas, Calif., markets to growers a line of produce bags that have variable permeabilities to carbon dioxide and oxygen. The bags can increase shelf life up to 100 percent, depending on the fruit or vegetable, according to Sannai Gong, R&D manager at River Ranch.

But ambient gases are only part of the problem. Meat doesn't last long in the presence of bacteria, and pathogens such as salmonella and some strains of *Escherichia coli* present a real hazard to consumers. One solution—irradiating food with high-energy particles—kills bacteria quickly and efficiently. Although the procedure has met with some consumer resistance, Connelly expects it to become an important technology. He envisions underground vaults filled with radioactive materials, rather like a walk-in x-ray machine: "You could drop in whole packaged food products and have them emerge stable," he asserts.

But if high-energy particles don't appeal, perhaps high pressure is more palatable. Although no one is quite sure how it works,

Labuza says that pressures of 240 to 275 kilopascals (35 to 40 pounds per square inch) efficiently sterilize packaged food. "You take guacamole, put it in a plastic package and put it in a cylinder, fill it with water, and then use a piston to pressurize the whole system. In a matter of minutes, you can kill most of the spoilage and food-poisoning organisms," Labuza says.

Once sterilized, the food could be shielded from outside contamination by shrink-wrapped packaging with antibacterial molecules incorporated right into it. Thus sequestered, food should be well preserved from microbiological hazards, but it faces one other challenge: oxygen can infiltrate the packaging and cause it to become rancid. To block it, packagers have added "oxygen traps"—in some cases simply iron—that react with oxygen before it can attack the contents of the package. The payoff is packages of meat that could last several years unrefrigerated.



WILLIAM LANGRIDGE Loma Linda University School of Medicine

A strain of bintje potato, genetically engineered to produce trace amounts of cholera toxin, immunized mice that ate it. Clinical trials with humans are expected within a year. The edible vaccine was created at the Center for Molecular Biology and Gene Therapy at Loma Linda University School of Medicine in California.

Whatever the future may bring, it seems certain to end the refrigerator biology projects that greet most returning travelers today. Slimy vegetables, rancid meat and nutritionally bankrupt starches could also be eliminated. And test-tube chicken could be the main course.

Will our taste buds be titillated? Or will manufacturers get caught up in a frenzy and make the same mistakes soy food producers made in the 1970s, sacrificing everything—including taste—for the sake of health benefits? Let's hope they do not, or the food of the future might be old-fashioned carry-out cheeseburgers and fries.

ABOUT THE AUTHOR

JIM KLING is a science and technology writer in Bellingham, Wash. He has mixed feelings about the idea of a synthetic fish fillet sandwich.