Edible coating made from silk can extend shelf life of foods

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Credit: AI-generated image (disclaimer)

The Silklab at Tufts University has pioneered the use of silk as a biological solution for many technological challenges. Just like the silk that goes into fine fabric, the silk used in the lab comes from the cocoons of silkworms, but it is processed in a very different way to break it down to its fibrous protein base. Tufts researchers have formed

that base into all sorts of useful materials, from faux leather to optical sensors to glue that can be used underwater.

One use of silk protein has already found a foothold in the marketplace: as an edible coating that helps extend the shelf-life of many kinds of foods.

Silklab director Fiorenzo G. Omenetto, the Frank C. Doble Professor in the Department of Biomedical Engineering, spoke with Tufts Now about discovering silk's preservative qualities and what widespread use of silk coating on fruits, vegetables, meats, and other foods could mean for mitigating food waste worldwide.

Tufts Now: How do you use silk in your lab?

Fiorenzo Omenetto: Silk is very well known as a textile commodity. The silk that we use is a little bit different in the sense that instead of taking the fibers and weaving them into clothes, we take the fibers and melt them into a liquid. We transform this liquid into a variety of materials. They can be plastic-like, or coatings, or blocks, or sponges. It can be turned into electronics. It's a very nice, water-based protein and it's very bio-friendly. You can eat it and you can implant it with no harmful effects.

What gave you the idea to use silk as a preservative?

I'm embarrassed to say that this was not the product of long, sleepless nights. It was more serendipity, encouraged by conversations I had in the hallway with David Kaplan and plain curiosity. We were doing experiments on blood analysis in our lab, so we had some blood samples. Because it was Halloween, we said let's make a film of silk and blood.

Wait—you mean because it's spooky?

Absolutely. This was the deep thought that we had. And so we made it and felt proud of ourselves and then completely forgot about it. And we came back a couple months later and saw that where you would expect the blood to have turned brown, the samples were still bright red. And so we observed that there were these preservation qualities in the silk, which led to a series of studies on many different aspects of stabilization.

You published a study in *Scientific Reports* that described how you coated pieces of fruit—strawberries and bananas—in silk and left them at room temperature. Compared to the uncoated fruit, the strawberries were still red and firm after a week and the bananas didn't turn black and overripe. How did you do it?

Basically, we wet the surface of the fruit with the liquid formulation of silk. When it dries it makes a very thin film—about one fifth the diameter of your hair. And it's transparent and tasteless. And it acts as a protective barrier. It regulates the respiration of each fruit.

Is the silk coating keeping something out or keeping something in? Or both?

A little bit of both. It really depends on what food you are working with. You could preserve a dry food you want to keep dry like nuts or a meat like steak. For a strawberry, you might want to keep the moisture in but keep pathogens out. You can regulate the coating—how you apply it, how much permeability it has.

This research on silk as a preservative became the basis for a company, Mori. What is its purpose?

Through the talent of the people who built the company—including Benedetto Marelli, an alum of the lab who is now is a professor at MIT—it has taken silk coating to an industrial scale to the point that it is a product on the shelves. Silk-covered spinach is now being sold in major retail stores in the Northeast.

It's great that my strawberries will last longer once I get them home from the store, but what are the wider ramifications?

Across the globe, we waste a staggering quantity of food—more than a billion tons of food are wasted each year—so certainly anything that can be done to mitigate that has a positive effect. Whether it is making it easier to preserving food in places that don't have access to refrigeration, or adding to a food's shelf-life in a store, or keeping food fresh longer in our homes so we don't throw it away—all those things are very important in reducing our carbon footprint.

What happens in the body when a person eats silk?

Hydrolyzed silk and powdered silk have been used and consumed in parts of the world as food additives for a long time. Some people say that they are very powerful antioxidants or great dietary supplements. I don't think that I am qualified to speak deeply about these things, but if I go by some of the medical uses, purified and reconstituted silk protein, such as the one we use, is very inert.

Do you think consumers will accept the idea of eating something that came from an insect?

This is a very difficult question to answer. In some parts of our world

people eat grasshoppers and crickets, and there is a whole movement toward using insects as an alternative meat. There are many glazes and colors in our food that come from a variety of insects. Awareness plays a big role in what we consume. We, knowingly or unknowingly, accept many chemicals and additives that we eat in our food. These things are very hard to predict, and I believe that there is, unfortunately, not one universal solution with just positive attributes, so we will see if there is an overall global benefit in this approach.

Silk clothing is expensive. So how can it be cost-effective to coat food in silk?

The very expensive silk thread that goes into equally very expensive clothing has very particular qualities. We don't really care about those qualities of the threads because we dissolve the fibers anyway. We can basically use any silk, and it takes very little silk to protect food, which makes the price point work. And unlike the textile industry, we don't necessarily need to kill the silkworms to use their cocoons. In the future, with synthetic biology-based approaches, we may be able to express the protein at large scales using bacteria, plants, or other carriers rather than extract it from cocoons, so you would not actually need the textile supply.

How do you see silk impacting the food system and other industries?

Generally speaking, biomaterials such as silk, whether grown or synthesized, are going to open an exciting chapter in materials science where the worlds of biology and technology are integrated into "living materials" that will change the way that we think about the objects that surround us. This could revolutionize global health, food safety, and, importantly, generate sustainable approaches that not only can preserve

the world we live in, but also offer new opportunities for manufacturing and industry.

Provided by Tufts University

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