Fluorescent dyes routinely light up cells and tissues under the microscope. And as microscopy techniques achieve higher resolutions, biologists will need dyes that glow more brightly and last longer. Xiaogang Liu leads a team at the Singapore University of Technology and Design that develops new and better fluorophores. But one personal project of Liu’s involves cataloging the natural fluorescence of products such as oils, honeys, and wines as a novel way to fight food fraud. By plotting the characteristic fluorescence of each product across a range of wavelengths, Liu and his students have built a small library of these fluorescence fingerprints.

With these fingerprints, Liu hopes to identify adulterated food products or even gutter oil—illicit cooking oil made by recycling waste grease and fat. This counterfeit oil is sold to street-food vendors and restaurants in Asia, despite repeated crackdowns. With prolonged heating and recycling of oils, harmful substances like heavy metals or polycyclic aromatic hydrocarbons accumulate, changing the oils’ fingerprints. What’s more, producers use chemical additives to adjust the oil’s color, cloudiness, pH, and other parameters so that it closely resembles unadulterated cooking oil.

XiaoZhi Lim spoke with Liu about how these fluorescence fingerprints could help identify gutter oil and other types of fraudulent foods.

How do you fingerprint fluorescence?
We collect a so-called excitation emission matrix with a fluorescence spectrometer. We first excite the sample at 300 nm and collect one emission spectrum. And then we move our excitation wavelength to 310 nm, and we collect another emission spectrum. We repeat the procedure until we collect many emission spectra, and when you put all the spectra together, they will form a matrix. That matrix, when you plot it, becomes like a picture, almost like a fingerprint.

Everything can be done in one go. We can finish each measurement within a few seconds.

The fluorescence fingerprints are unique because the combination of chemicals in a product is unique. It would be very difficult to reproduce the same fingerprint by adding different chemicals into the product.

What products have you tested?
We tested a variety of oils: sunflower oil, olive oil, basically all the oils available in the supermarket. After the oil work, we extended this idea into many other products, like wines, vodkas, honeys, shampoos. We even measured the fluorescence fingerprints of Coke versus Pepsi, and we can tell the difference. We tested about 50 types of wines, and we are still doing more testing, but wine is expensive so most of the samples are actually from our friends.

One of my friends, his hobby is tasting different vodkas. He can tell it’s a different taste, but he doesn’t know how to describe that. Now we can show that different types of vodka have different fingerprints, so in a way we turn the taste into a picture, so that people can see that. I think that’s kind of cool. So companies can use it for branding to differentiate their products.

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How can fluorescence fingerprinting help to identify gutter oil?

The production of gutter oil was very bad a few years ago in some Asian countries. It’s a very challenging goal to precisely identify how gutter oil is made and how long it has been subjected to heat treatment because there are hundreds and hundreds of chemicals in the oil, and many things will happen as we do the heating.

I think solving this problem effectively will be through the government implementing laws to tighten regulations. But to really enforce it, the technique for analysis has to be very simple and fast. It’s very challenging to do a detailed analysis of the oil, but now the fluorescence fingerprints provide a simple solution. This measurement is very cheap; it doesn’t require any sample preparation.

Can you tell how long an oil has been heated?

In the lab, where many things are controlled, we can establish a very good linear correlation between the fluorescence intensity versus the heating time. So based on that data, we are able to very precisely tell how old this oil is. If we go to the real world, the change we can expect in the pattern of fluorescence fingerprints will become much more complicated. For example, intensity may increase because of the addition of new chemicals instead of just heating.

But perhaps we can create a central database with all the fluorescence fingerprints. Let’s say someone did something bad—added gutter oil into some good oil—the food safety authorities can easily tell that this oil has been contaminated by comparing the new fluorescence fingerprint versus the original fingerprints recorded in the system. We can also use fluorescence fingerprints to track the authenticity of products. So I think that’s a simple solution to this complicated issue: we don’t know what they have done, but we can at least tell that it’s different and that the oil has been adulterated.

Can this fingerprinting technique tell you anything about the nutritional value of various cooking oils?

I’m not a food chemist, but I will share one interesting observation. It’s common knowledge that extra-virgin olive oil is very sensitive to heat treatment. When my student tried to measure the fluorescence fingerprint of extra-virgin olive oil, she was shocked because before and after the heat treatment, she saw a huge difference in the fingerprint. Before heat treatment, extra-virgin olive oil has its unique fingerprint from chlorophyll in the visible region. But after the heat treatment, the fingerprint became almost like a very cheap sunflower oil.

XiaoZhi Lim is a freelance contributor to Chemical & Engineering News, the weekly newsmagazine of the American Chemical Society. Center Stage interviews are edited for length and clarity.