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What Color Is Your Tuna?

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Wednesday, October 27, 2004; Page F01

I love sushi, especially the yellowfin nigiri. The raw tuna sometimes has different colors, however, ranging from light to dark red. I never thought much about it, but I just read a story in the newspaper saying that raw tuna is being treated with carbon monoxide to give it a bright red color, even if it isn't fresh. Isn't carbon monoxide lethal?

Yes it is, under the right -- that is, the wrong -- circumstances. But not in the case of monoxide-treated tuna.

First, for the uninitiated, yellowfin tuna, which may be listed on the menu as maguro, the generic Japanese word for tuna, is not to be confused with yellowtail, a kind of amberjack, or with toro, the prized fatty belly of the bluefin tuna. Nigiri sushi is a filet of the raw fish on a pillow of vinegared rice.

Malignant monoxide

Every year in the United States, several thousand people are treated in hospital emergency rooms for carbon monoxide poisoning. Some 200 per year die from carbon monoxide given off by improperly vented gas-burning appliances such as furnaces, ranges, water heaters and room heaters, while many others are killed by automobile engines running in enclosed spaces.

Carbon monoxide gas is particularly toxic because it goes from the lungs into the bloodstream, where it replaces the oxygen in the blood's oxyhemoglobin, destroying its ability to deliver oxygen to the body's cells. And the organs most likely to crash from oxygen starvation are the heart and brain.

All devices that burn carbon-based fuels, including gasoline-burning automobiles, gas-burning furnaces, kerosene-burning heaters and even charcoal-burning hibachis, emit carbon monoxide because their fuels don't burn completely; the combustion process is inevitably inefficient. Instead of burning all the way to carbon dioxide, CO₂ (two oxygen atoms for every carbon atom), some of the carbon atoms in the fuel can't find that second oxygen atom and end up as carbon monoxide, CO. That's why these devices should never be operated in an enclosed space.

Benign monoxide

Eating raw tuna that has been exposed to carbon monoxide gas is another matter entirely. In this case you're not breathing the gas, and for that matter you're not even eating it. Gases, of course, are ephemeral, and the carbon monoxide doesn't hang around on the fish after it's done its job of brightening its color. The FDA has declared carbon-monoxide-treated tuna to be GRAS -- generally regarded as safe -- because residual carbon monoxide on the fish is virtually absent.

But why should a food processor do such an outlandish thing as exposing fish to a poisonous gas? Well, follow the money. The red color of freshly cut tuna can change within a few days to an unappetizing brown. Consumers don't like brown fish and are willing to pay more for "fresher-looking" red. Hence, the cosmetic application of carbon monoxide rouge.

Tuna flesh, like the flesh of many land animals, contains myoglobin, a pigmented protein that stores oxygen in the muscle tissue. Myoglobin changes color, however, depending among other things on how much oxygen is available to it. The dark, purplish red color of freshly cut tuna is due to deoxymyoglobin, which in air changes first to bright red oxymyoglobin and then to brown metmyoglobin. Tuna purveyors must therefore hustle to rush their tuna from the boat to the sushi bar while it is still in the red oxymyoglobin stage.

Carbon monoxide thwarts these color changes by replacing the oxygen in the oxymyoglobin molecules (as it does in our blood's oxyhemoglobin molecules), converting them into a very stable complex: the watermelon-red carboxymyoglobin. The oxymyoglobin is thus derailed from being oxidized to brown metmyoglobin.

Tuna cosmetologists can of course buy their carbon monoxide gas in steel tanks, like many other gases. But there's a cheaper way to get it: by burning wood. Because of the incomplete combustion process described above, wood smoke contains carbon monoxide. The tiny particles that make smoke smoky can be filtered out along with the chemicals that give smoke its flavor, leaving a mixture of gases -- carbon dioxide, carbon monoxide, nitrogen, oxygen, and methane -- called filtered smoke or tasteless smoke. It can be used instead of pure carbon monoxide to brighten the fish's color. The justification is made that tasteless smoke can be no more harmful than "whole smoke," traditionally used to make smoked fish and other meats. According to the FDA, however, foods treated with filtered smoke may not be labeled "smoked," because the expected smoked flavor isn't there.

So what's the problem?

The irony in all this is that the color of untreated tuna is not an indicator of its wholesomeness. Myoglobin's color changes take place long before the fish has begun to deteriorate. The association of bright color with freshness is all in the consumer's mind.

So is there anything wrong with carbon-monoxide-treated tuna? Not because of any presumed health hazard. But there will always be a few rascals who try to conceal over-the-hill fish by touching up its color, and that is an actionable offense according to the FDA. Recent research by the Food Science and Human Nutrition Department of the University of Florida has found that dangerous time-induced spoilage can continue in monoxide-treated fish even though the color is still bright.

For reasons such as this, several countries prohibit carbon-monoxide-treated fish. Sushi-conscious Japan has outlawed it since 1997, while the European Union has begun to enforce its ban only since early this year.

Your best resource as a consumer is, as usual, your confidence in your source. You shouldn't eat raw fish in any but the most trustworthy sushi establishments anyway, for health reasons unrelated to carbon monoxide. If a given restaurant would never sell spoiled fish under other circumstances, it would certainly never sell spoiled fish that has been cosmetically enhanced. Fresh tuna has a clean flavor, relatively firm texture and, of course, no odor, no matter what its color. So if in doubt, just shut your eyes and let your mouth and nose be your guides.

And remember that yellowfin tuna varies in color from pink in smaller fish to deeper red in larger fish, so once again the color itself is no indication of freshness.

If your fish is a bright, unnatural-looking watermelon red, it has probably been treated with carbon monoxide. So what? It won't kill you. But you shouldn't have to pay top-shelf prices for it.

Robert L. Wolke (www.professorscience.com) is professor emeritus of chemistry at the University of Pittsburgh and the author, most recently, of "What Einstein Told His Cook: Kitchen Science Explained" (W. W. Norton). He can be reached at wolke@pitt.edu.

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