The fructose connection: Copper and heart disease

Nature sometimes seems to have a malicious sense of humor. Fructose, the sugar found in honey and fruit, has been in vogue for more than a decade as a natural, good-for-you sweetener. Twice as sweet as table sugar, it is economical as well as fashionable; its use has increased seven-fold since the introduction of high-fructose corn sweeteners in 1970. Now, it is being implicated in heart disease.

New research indicates that high levels of fructose exacerbate the effects of copper deficiency, a factor that has already been linked to coronary problems, including high cholesterol levels (SN: 6/8/85, p. 357). According to the Agriculture Department's Research Service, the average U.S. diet contains only about half the amount of copper estimated to be adequate – a consequence of food processing.

In the latest study, reported in St. Louis at the recent meeting of the Federation of American Societies for Experimental Biology, young pigs were given either a copper-deficient diet or one adequate in the mineral; some of each group were fed high levels of fructose, and the others were fed high levels of a different sugar. There were no outward signs of serious health problems in the copper-deficient groups, though blood tests showed abnormally low levels of copper-containing enzymes. "The pigs weren't any the worse for wear; they just didn't have any copper in their serum," says Norman Steele, of the Research Center in Beltsville, Md. But when the pigs were sacrificed after 10 weeks, the researchers found that those on the high-fructose/low-copper regimen had hearts twice as big as the hearts of any of the other animals.

"It's a totally abnormal condition. And we were able to demonstrate this in a very young pig, which under any other circumstances just wouldn't show any cardiac pathology," says Steele, who led the study.

Steele thinks the cardiac damage will turn out to be the result of several key factors. Animals on the copper-deficient, high-fructose diet had extremely low levels of two enzymes, one essential in building the connective tissue that binds the heart muscle together, the other protecting cells by scavenging toxic metabolites. These animals had very high tissue levels of iron, which can cause cell membranes to erode. Moreover, says Steele, the lactic acid created in large amounts by fructose is preferentially used by the heart – and that causes "otherwise soluble muscle protein, like cardiac muscle protein, [to precipitate] out of solution .... in many ways [it] looks like rigor mortis that would occur postmortem, except the animals are still alive."

The research on pigs grew out of a study last year that compared the effects of fructose and cornstarch on human volunteers eating a copper-deficient diet. That work was cut short, according to Sheldon Reiser, the Beltsville researcher who led the project, when some of the volunteers developed temporary, but potentially severe, heart-related medical complaints. "We were seeing abnormalities we had never seen before in all the years of our experiments," Reiser told SCIENCE NEWS. "Four out of 23 [volunteers] showed some heart-related abnormalities."

In that study, some volunteers on the starch-heavy and some on the high-fructose diets showed heart problems. But there was a strong fructose-specific effect in the pig study, and, Reiser says, that has clear implications for humans. "With the type of diet being consumed in America today, conditions are there, in a chronic way, to accent the copper deficiency – and be one of the contributing factors to heart disease." *– L. Davis*