Dietary Dogma Disproved

Nutritionists find that some complex carbohydrates act like simple sugars and vice versa

For years, diabetologists and nutritionists have taught that there are two major classes of carbohydrates: simple and complex. Simple carbohydrates, which are the sugars like glucose, sucrose, and fructose, are immediately absorbed by the gut and cause a rapid rise in blood sugar and blood insulin. Complex carbohydrates, such as the starches found in rice and potatoes, take longer to be absorbed and so result in a slower and more moderate rise in blood glucose and blood insulin.

Or so the dogma goes. But it turns out that the dogma is incorrect. The problems, says Jesse Roth, a diabetes specialist at the National Institutes of Health, is that "I believed it. Everyone believed it. But no one ever tested it."

When Phyllis Crapo of the University of Colorado Health Sciences Center in Denver thought to test the dogma, she was astonished to find just how wrong it is. Crapo and other researchers are learning, for example, that a bowl of ice cream does almost nothing to blood glucose. Nor does a sweet potato. But a white potato or a slice of whole wheat or white bread sends blood glucose soaring. To further compound the matter, the effects of carbohydrates on blood glucose are unpredictable. The only way to learn what a particular food's effect is is to test it on volunteers.

These discoveries are of major consequence for diabetics, who must avoid large swings in blood glucose. They also may be important for nondiabetics since, at the very least, large amounts of glucose in the blood make people sleepy.

Other effects are more speculative, but some medical researchers now suggest that the reason people develop adult-onset diabetes may be because they eat the wrong kind of carbohydrates, meaning those that give rapid rises in blood sugar, rather than simply too many carbohydrates. In more primitive societies, David Jenkins of the University of Toronto points out, people tend to eat the carbohydrates that give slow glucose rises and tend also to have little diabetes and heart disease.

Crapo first thought of testing the conventional wisdom about the effects of simple and complex carbohydrates when she visited Stanford University several years ago. She was sitting in on a physiology class when the lecturer remarked that the traditional advice to diabetics that they eat complex rather than simple carbohydrates really makes no sense. People have so many amylases—enzymes that break down starches into sugar—in their gut that starches are converted to glucose almost immediately.

Crapo was skeptical. As a nutritionist, she had been advising diabetic patients to concentrate on complex carbohydrates and she found it hard to believe that they are no different from simple sugars as far as blood glucose is concerned. So she, together with Stanford diabetologist Gerald Reaven and her husband, diabetologist Jerrold Olefsky, also of the University of Colorado, decided to feed volunteers pure uncooked starch and see what happened. Just as she suspected, there was virtually no rise in blood glucose.

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But, these investigators reasoned, pure uncooked starch is hardly a typical food. Perhaps the result would be different if they tried cooked starches of the sort people normally eat. They then fed volunteers potatoes and rice. To their amazement, says Crapo, "We found a dramatic difference between the two. Rice gave a flat glucose response and potatoes gave a rapid response that was the same as you would expect if you gave people pure glucose." Olefsky adds, "Potatoes are like candy as far as a diabetic is concerned."

They went on to test corn and bread because rice, potatoes, corn, and bread are the four major starches eaten in this country. The glucose responses, in increasing order, were rice, bread, corn, potatoes.

They tried the experiments in people with impaired glucose tolerance and with diabetes. The results were the same. They tried similar experiments using simple sugars because, Olefsky explains, "We always were taught that a simple sugar is a simple sugar. But it turns out that simple sugars are as different as potatoes and rice." Lactose and fructose have little effect on blood glucose. Sucrose has a moderate effect. Glucose and maltose give immediate and pronounced effects.

Olefsky believes that one reason for these differences is that there are differences in the accessibility of the starch or sugar molecules in various foods. The more homogenized the food, the more rapid the rise in blood glucose. A rice slurry gives a more rapid rise than rice grains. Apple puree gives a more rapid rise than a whole apple. But the biochemistry of food digestion and absorption is so poorly understood, he says, that each food has to be analyzed separately.

The most extensive list of the glucose responses of foods has been prepared by Jenkins and his associates in Toronto working with Thomas Wolever and his associates at Oxford University.

Jenkins says his studies of the glucose response to various foods are a constant revelation. "We never cease to be amazed. We are unable to predict and we are still trying to explain what we find. We thought we would find most of the foods not too dissimilar. We expected some differences but not massive differences. A second surprise—and this was quite, quite remarkable—was that the legumes had blood glucose rises half those of their cereal counterparts."

Pasta products are much lower in their blood glucose effects than cereals. "In the West, we've been getting hooked on whole meal products rather than white. But there is no difference in blood glucose levels with white or whole wheat pasta, white or whole wheat bread, or white or brown rice," Jenkins remarks. He stresses, however, that whole wheat products still may be beneficial since they improve colonic function.

Jenkins and Wolever also have tested combinations of foods. For example, they gave volunteers cheese and bread. Dairy products in general give a very slow glucose rise but the cheese-bread combination, unexpectedly, gives the rapid glucose rise characteristic of

bread. Bread and beans, in contrast, resulted in a slow rise in blood sugar more characteristic of beans than bread.

One immediate consequence of these results for diabetics is that the starch exchange lists of their diets, which are choices of equal carbohydrate portions of bread, rice, potatoes, or corn, are called into question. In addition, Olefsky points out, diabetics may want to know that some foods that they frequently avoid, such as ice cream, are fine as far as blood glucose is concerned. Olefsky remarks that he recently saw a new ice cream sweetened with sorbitol and labeled "not a low calorie food." The ice cream was aimed at diabetics. But regular ice cream gives a very flat glucose response. Marveling at the very existence of this dietetic dessert, Olefsky says, "Some major food company developed this product on the assumption that ice cream is bad for diabetics. Better they should go out and find a better potato."

Roth says it is his impression that the work of Crapo and Jenkins "is not widely known" and that "it is time for it to be considered" by diabetologists. Irving Spratt of the Spratt Diabetes Medical Clinic in San Bernadino, who is president of the American Diabetes Association, says the Diabetes Association is concerned about the possibility that the starch exchange lists may be misleading, that "we are considering changing the exchange lists and we will take appropriate action as all the evidence comes in." Crapo, he adds, is a member of the professional education committee of the American Diabetes Association. "We are in constant communication with Phyllis Crapo," Spratt says.

Studies of carbohydrates and their effects on blood glucose may help nutritionists understand public health issues as well as diabetes diets. Jenkins says he wonders whether the wholesale change in industrialized societies from foods like pasta, beans, and sweet potatoes to foods like bread, cereals, and white potatoes might be related to the prevalence of diabetes, heart disease, and some forms of cancer. He himself has begun eating pasta and beans since he discovered their effects on blood glucose. "It's a marvelous food anyway," he remarks.

Olefsky wonders whether there will be any large-scale health effects as food manufacturers switch from using sucrose as a sweetener to using corn syrup, which is less expensive. Corn syrup, which is mostly fructose, gives a very slow blood glucose response whereas sucrose gives a more rapid one.

The whole process of studying the blood glucose response of foods has been an eye-opener for nutritionists. They learned, says Crapo, that "What happens when we eat food is much more complex than anyone thought." Now that researchers are starting to look more carefully at their untested assumptions about food, Crapo predicts, "I think at last we will pull nutrition out of the dark ages."—GINA KOLATA

Additional Reading

1. D. J. A. Jenkins, R. H. Taylor, T. M. S. Wolever, "The diabetic diet, dietary carbohydrate and differences in digestibility," *Diabetologia* **23**, 477 (1982).

The Two Sides of the Brain

Behavioral asymmetries are linked to physical asymmetries in the brain; abnormal brain development may underlie learning disorders like dyslexia

At one time, cerebral dominance was thought to be a uniquely human trait. Only in humans, it was thought, is a particular activity or behavior such as speech under the primary control of one or the other of the brain hemispheres—a trait that is reflected by marked anatomical, chemical, and electrical asymmetries in the brain.

But now, as was repeatedly demonstrated at a recent conference in Boston on "The Biological Foundations of Cerebral Dominance," these brain asymmetries are being found in lower animals.* This gives researchers a way to study just what cerebral dominance means.

A major reason for the interest in these asymmetries is the association between childhood learning disorders and the development of anomalous dominance in the human brain. In most people, the left hemisphere has dominance over language abilities. But in a minority, the exact size of which is unknown, the right has gained at least partial dominance. These individuals are at higher risk of having language-related learning disorders, such as dyslexia, difficulty in learning to read.

More than a century has passed since certain behaviors were found to be more under the control of one brain hemisphere than the other. For example, in the early 1860's Pierre Paul Broca identified a region on the left side of the brain—Broca's area—that is important for speech control in most persons, especially right-handers. Left-handers are more likely to have some or all control of their language in the right hemisphere.

Until the late 1960's, the general consensus was that cerebral dominance existed independently of anatomical asymmetries in the brain. However, in 1968, Norman Geschwind and Walter Levitsky, who were then at Boston University School of Medicine, showed that easily observable differences, visible even to the naked eye, could be detected between structures in the left and right hemispheres.

Many asymmetries can be detected in the cortex, the outer layer of the brain and the site of such complex functions as language and control of voluntary actions. Geschwind and Levitsky found the planum temporale, a cortical area involved in speech, to be larger on the left hemisphere than on the right in about two-thirds of the brains examined. It was larger on the right in about 10 percent, and roughly the same size on both sides in the remaining brains.

More recently, Albert Galaburda and his colleagues at Harvard Medical School found additional speech areas to be larger in the left hemisphere of most brains than in the right. The language system as a whole may be asymmetric, he told the conference participants.

The asymmetries extend to the level of individual neurons, according to Arnold Scheibel of the University of California at Los Angeles. He described work from his laboratory that was undertaken to determine whether the dendritic structures of neurons from speech centers on the left side of the brain differed from those of corresponding neurons from the right hemisphere. The dendrites are neuronal projections that receive incoming

*The conference, which was held on 4 to 6 April, was sponsored by Harvard Medical School and the Institute for Child Development Research.