

## Fructose and Its Advantages Over Other Natural Sugars

Fructose is a natural sweetener found in honey, fruits, berries, and vegetables. Fructose is among the most commonly consumed simple sugars—along with glucose (found commonly in candy, gum, jams) and sucrose (table sugar). For example, an apple contains an average of 15 to 20 grams of sugar, the majority of which is fructose.<sup>1</sup> With regard to taste, fructose is approximately 1.7 times sweeter than sucrose and 2.3 times sweeter than glucose. Because fructose is sweeter than sucrose or glucose, less fructose is required for the same sweetness effect.

Although fructose is a simple sugar, like glucose, and is part of the sucrose molecule (sucrose is composed of glucose and fructose bonded together), its glycemic index (GI) is much lower than that of glucose or sucrose. In fact, fructose is known to have the lowest GI of any of the sugars—a GI of about 20, compared to about 100 for glucose.<sup>2</sup> And little or no increase in blood sugar is noted after ingestion of large amounts of fructose.<sup>3</sup> This fact has led to the promotion of fructose as the preferred sugar source for diabetics.<sup>4</sup>

Fructose is absorbed in the gastrointestinal tract primarily through a facilitated transport process, and fructose absorption is slower and less effective than that of glucose.<sup>3</sup> Sucrose is broken down to fructose and glucose during digestion, and fructose absorption is increased in the presence of glucose, possibly due to the ability of glucose to alter intestinal permeability.<sup>5</sup> Therefore, less fructose may be absorbed when it is used as the primary or exclusive sweetener than when it is digested in the form of sucrose. In humans, at moderate intake, most fructose is immediately converted into glycogen—a process that requires energy and prevents fructose from reaching direct circulation.<sup>3,5</sup> This may be one of the reasons

consumption of fructose does not significantly increase blood sugar levels. At high intakes, fructose is also metabolized to pyruvate and lactate, which can be used as building blocks for lipids.

A recent trial demonstrated that ingestion of 50 grams of fructose led to only a modest increase in blood fructose, glucose, and insulin levels after a glucose challenge. And no increase was seen in blood glucose levels after ingestion of fructose at 15 grams or less.<sup>6</sup> The lowered glycemic response with fructose ingestion appeared to be most effective in those individuals who had the poorest glucose tolerance profiles.<sup>6,7</sup> Another study demonstrated that 7.5 grams of fructose significantly lessened the glucose peak after given with a 75-gram glucose load in both healthy and type 2 diabetic adults. Researchers determined that this effect was not a result of stimulation of insulin secretion.<sup>8</sup> In non-diabetic individuals, fructose consumption resulted in little to no discernable rise in blood insulin levels.<sup>4</sup> Research suggests that fructose is approximately 30% less potent than glucose at promoting insulin secretion in individuals with insulin dysregulation.

In a human clinical trial, 13 patients with type 2 diabetes were instructed to consume either the standard American Dietetic Association (ADA) diet or the standard ADA diet plus 60 grams of fructose per day for 6 months. Consumption of fructose was associated with a significant decrease in both serum glycosylated hemoglobin and fasting blood sugar levels.<sup>9</sup>

Although fructose has been shown to have many benefits in comparison to glucose or sucrose, it is nevertheless a sugar and people with sensitivities to sugars, such as insulin-deficient individuals, should carefully monitor their total sugar intake.

As one scientific review points out, most human studies have shown conflicting results—partly because of heterogeneity of design and/or high intakes of dietary sucrose or fructose.<sup>10</sup> For instance, some human studies have shown an increase in serum triglyceride levels after fructose consumption. It is important to keep in mind, however, that participants in these studies are commonly instructed to consume a single serving dose of 50 grams of fructose or more in addition to a high-fat intake.<sup>11</sup> Therefore, the ability of fructose to promote insulin resistance has not been clearly shown, and most recent clinical trials performed to clarify the role of fructose have shown that it improves both glucose and insulin peaks induced by other sugars. In addition, fructose alone appears to result in little or no increase in blood sugar and insulin levels.

A recent article by Peter Havel's group at the University of CA, Davis has caused some controversy surrounding fructose.<sup>12</sup> In his article, Dr. Havel hypothesizes:

“Because fructose does not stimulate insulin secretion from pancreatic beta cells, the consumption of foods and beverages containing fructose produces smaller postprandial insulin excursions than does consumption of glucose-containing carbohydrate. Because leptin production is regulated by insulin responses to meals, fructose consumption also reduces circulating leptin concentrations. The combined effects of lowered circulating leptin and insulin in individuals who consume diets that are high in dietary fructose could therefore increase the likelihood of weight gain and its associated metabolic sequelae.”

Dr. Havel's article appears to be aimed not at natural fructose, but at the soft drink industry—which uses large amounts of high fructose corn syrup (HFCS) as sweetener in their products. This is very apparent since most of the research Dr. Havel uses to support his hypothesis comes from consumption of fructose in the form of HFCS or sucrose, not fructose alone. Fructose and HFCS are different, but unfortunately many people confuse them. In fact, HFCS contains a combination of glucose and fructose. Most preparations of HFCS are approximately 50% fructose and 50% glucose; therefore, HFCS is more similar to sucrose than it is to fructose. In fact, several studies have compared

HFCS to fructose in humans and shown distinct differences. For example, when non-insulin-dependent diabetics were given equicaloric amounts of HFCS or fructose, blood glucose and insulin levels were significantly increased with the HFCS over the fructose.<sup>13,14</sup>

Even in his own report Dr. Havel makes it clear that moderate levels of fructose intake are not a problem:

“First, added fructose (in the forms of sucrose and HFCS) does not appear to be the optimal choice of carbohydrate in the diet. Small amounts of fructose are probably benign and may even have some favorable metabolic effects....Second, the concerns raised about the addition of fructose to the diet as sucrose or HFCS should not be extended to naturally occurring fructose from fruit and vegetables.”

Throughout his report, Dr. Havel cites research in which fructose is given from HFCS or sucrose and at levels at least 20% to 30% of daily caloric intake. This is not an uncommon amount to use in a research study, but in an average American diet (1800–2500 Cal/day), that would equate to between 90 g and 188 g of fructose per day, an extremely high amount of sugar. With the increased consumption of soft drinks, this high amount of sugar is a concern in the American diet. Small amounts of fructose, by Dr. Havel's standards, include 15 gram amounts; and 15 grams of fructose only contributes 2 - 3% of daily caloric intake, a level that is 10 times less than the amount used in the majority of research studies.

Since many factors can influence the blood sugar and insulin responses, the best course of action for individuals that are sensitive to sugars, such as patients with insulin resistance, is to choose products that have been tested and shown to have a low GI response.

#### **In summary:**

- Fructose is the main sweetener found in honey, fruits, berries, and vegetables.
- Fructose is a natural, low glycemic index (GI) simple sugar with a high sweetness profile.
- Fructose is absorbed by the body through a facilitated transport process, which leads to a

slower and decreased level of absorption than that observed for glucose.

- Fructose does not increase blood sugar after normal levels of consumption, and only modestly increases it after a large bolus dose (approximately 50 grams).
- Fructose is not the same as high fructose corn syrup (HFCS). HFCS is a combination of glucose and fructose and is added to many processed foods at high levels.

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