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Nutritional Aspects of Bulk Sweeteners Compared with Sucrose

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ABSTRACT

Each of the main bulk sweeteners is a carbohydrate varying from a polysaccharide to a monosaccharide, and consequently they have different effects on body physiology when consumed. The nutritional and metabolic aspects of the more common bulk sweeteners will be discussed, with emphasis on the differences between them.

Sucrose differs from other nutrient sweeteners in its chemical composition and it is the fructose moiety of the sucrose molecule that seems to be responsible for many of the properties that make it nutritionally different from other bulk sweeteners. However, even before they are metabolised, there are differences in the rate of absorption of the various bulk carbohydrates. The only two carbohydrates that are actively absorbed across the wall of the intestine are glucose and galactose, and this process is Na^+ dependent. Fructose is transported by facilitated diffusion, whereas the remainder of carbohydrates cross the gut wall passively down a concentration gradient. Hence, bulk sweeteners other than glucose or galactose may give rise to osmotic diarrhoea if taken by an adult in a quantity of 50 g or more. Glucose polymers are hydrolysed to the constituent monosaccharide and therefore do not result in intestinal hurry. Sucrose ingestion results in a higher concentration of fructose in the blood than an equimolar mixture of glucose and fructose. The most likely explanation for this is that sucrose, which is hydrolysed at the

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surface of the mucosa of the intestinal wall, leads to a high concentration of fructose at the absorbing surface, and this will accelerate its absorption.

The rate of absorption of amino acids seems to be influenced by the accompanying monosaccharide: fructose is associated with an increase in such absorption compared with glucose, and this has recently been confirmed for leucine in man.

A property of lactose, apparently not shared by other dietary carbohydrates, is that it seems to increase the absorption of calcium. One can only guess at the possible physiological significance of this in infants.

Having been absorbed, the level of glucose in the serum is not a measure of the extent of glucose absorption, probably because the rôle of insulin in preventing the level of blood glucose rising above renal threshold. In fact any dose of glucose between 0·25 g and 2·5 g per kg body weight gives, over 90 min, similar tolerance curves. However, the insulin response, as measured by the serum concentration of insulin, does seem to be dose:response related, in that the larger the amount of glucose consumed, the greater the area under the serum insulin curve. The insulin response to sucrose, as measured by serum insulin levels, is about half that to an equal amount of glucose or its polymers. This is to be expected, as fructose does not result in insulin release. It has recently been suggested that this property could make it useful in the diet of diabetics. A study was reported several years ago in which serum glucose and insulin were monitored continuously over a 24-h period in healthy men who were given meals containing isoenergetic amounts of either sucrose or corn syrup. The fluctuations in the serum glucose levels were more pronounced on the corn syrup, and the mean 24-h level of insulin in the serum was also greater after corn syrup ingestion than after sucrose.

Fructose, as such or in sucrose, is metabolised much more rapidly than glucose, as there is no rate-limiting step in fructose breakdown: two consequences of this are increases in the levels of lactate and of uric acid in the serum after ingestion. This could indicate that glucose or its polymers are the preferred carbohydrate in exercise.

Nearly 20 years ago it was reported that isoenergetic intake by rats of various carbohydrates did not result in uniform increases in weight, and similar findings were recorded in monkeys. In other experiments, when the energy content of the diet was reduced, rats lost weight more rapidly with glucose as the main carbohydrate source compared with sucrose, and similar findings are seen in man. In rat studies, it has been found that,

despite an isoenergetic diet as determined by a bomb calorimeter, animals on sucrose had more depot fat than those on glucose.

In an attempt to explain this apparent difference in weight gain or loss, despite isoenergetic intake, the metabolic rate following the ingestion of various carbohydrates was determined. It was found that after ingestion of sucrose or fructose, the rise in metabolic rate in the next 60–90 min was greater than that after glucose, maltose and lactose, so this would not account for the slower weight loss with sucrose.

There is a difference between sucrose and the other bulk sweeteners in respect to lipid metabolism. Sucrose causes a rise in the level of triglyceride in fasting serum, an effect that is probably short lived in man and that can certainly be over-ridden by polyunsaturated fat in the diet. All carbohydrates are associated with reduced levels of HDL cholesterol in the serum, and this 'scavenger' lipoprotein level is probably lower after sucrose than after glucose.

Thus, there are several nutritional differences between sucrose and other bulk sweeteners, and these differences seem to reside in the fructose moiety of sucrose so that, presumably, high fructose corn syrups would have nutritional effects similar to sucrose.

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