Glycemic Index Foundation (Ltd)

Position Statement

Glycemic index and sustainable (longer-lasting) energy

Definitions

The glycemic index, or GI, is a ranking of carbohydrates in foods and beverages according to their affect on blood glucose levels (1). To measure the GI, healthy individuals are given portions of a test food or beverage that contain a standardised amount of available carbohydrate, and their blood glucose levels are measured over a 2 hour period. On a separate occasion, the same group are fed an equivalent amount of carbohydrate in the form of pure glucose. The glycemic index is the average relative response of the test food/beverage compared to the glucose standard, which has a value of 100. Low GI foods and beverages are defined as those with a GI value less than or equal to 55, medium GI foods as those with a GI between 56 and 69, and high GI foods as those with a GI equal to or greater than 70 (2).

GI and sustainability of blood glucose levels

High GI foods and beverages have often been described as quick or "short- acting" sources of energy, while low GI foods are said to be "long-acting" or "sustained" sources of energy. These descriptions are physiologically valid, but they are not reflected in the shape of the blood glucose response curve, after eating high versus low GI foods (3).

Detailed analysis of thousands of foods shows that the notion that a low GI food has a uniquely long tail or extended blood glucose profile, compared to a high GI food, is incorrect (3). Both high and low GI foods reach their peak blood glucose levels at around 30 minutes, and return to fasting levels within 60 minutes, in healthy individuals. The peak height is higher after a high GI food, so the rate of increase per minute is higher and the rate of decline is faster. High GI foods show greater overall fluctuation, i.e. the difference between the peak and the trough is greater.

Blood glucose levels tend to return to baseline sooner after consuming sugary foods, including soft drinks and juices, regardless of their GI (3). These findings can be explained by the fact that commonly consumed sugars such as sucrose, lactose and fructose – regardless of their source – contribute fewer glucose moieties than the same weight of starch or pure glucose (3). Fifty grams of sucrose, for example, contains only 25 g of glucose equivalents versus 50 g of glucose equivalents in starch (3).

Are low GI sugary foods a source of sustained energy?

While lower GI sugars have a smaller effect on blood glucose levels, all their energy, whether it is derived from sucrose, lactose, glucose, fructose or galactose is absorbed over time, and becomes available as a fuel for the body's cells, tissues and organs.

For example, the 25 g of fructose or galactose from a 50 g serve of sucrose or lactose, respectively, still provide the body's cells, tissues and organs with metabolisable energy (provided an individual is not lactose intolerant). After reaching the liver, fructose is rapidly removed from the blood stream, phosphorylated, and enters the glycolytic pathway, usually ending up as pyruvate and adenosine triphosphate (ATP), our body's main energy "currency". The release of these alternate fuels (e.g., glucose, pyruvate) into the blood stream depends on the individuals energy balance (4). Similarly, galactose is extracted from the blood and converted to glucose in the liver, and again converted to pyruvate and ATP, just like dietary glucose. Under normal aerobic conditions, pyruvate is converted via the citric acid cycle to ATP, producing more energy. Therefore, ingestion of low GI sugars such as fructose, lactose or sucrose may have a negligible affect on blood glucose levels *per se*, but this does not mean they do not still help provide our body's cells, tissue and organs with a sustainable source of energy. The rate of energy release is not determined by the shape of the blood glucose response curve.

While data on individual food items are lacking, there is considerable evidence linking the consumption of meals (mixtures of starches and sugars) with a low GI to sustained physical (5-17) and improved mental (18-26) performance in humans. These findings may be linked to differences in insulin and fuel oxidation. For example, low GI meals have been shown to increase fat oxidation and reduce the proportion of energy burnt as carbohydrate (5).

Conclusion

A low GI food or beverage can be a source of sustainable energy, independent of the shape of its blood glucose response curve, as their metabolic energy can be released through alternative energy pathways (3).

References

(1) Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, Baldwin JM, et al. Glycemic index of foods: a physiological basis for carbohydrate exchange. Am J Clin Nutr 1981 Mar;34(3):362-6.

(2) International Organization for Standardization. Food products — Determination of the glycaemic index (GI) and recommendation for food classification. **ISO 26642:2010(E)**. 1-10-2010. International Organization for Standardization.

(3) Brand-Miller JC, Stockmann K, Atkinson F, Petocz P, Denyer G. Glycemic index, postprandial glycemia, and the shape of the curve in healthy subjects: analysis of a database of more than 1000 foods. Am J Clin Nutr 2008 Dec 3.

(4) Decombaz J, Jentjens R, Ith M, Scheurer E, Buehler T, Jeukendrup A, et al. Fructose and galactose enhance postexercise human liver glycogen synthesis. Med Sci Sports Exerc 2011 Oct;43(10):1964-71.

(5) Stevenson E, Williams C, McComb G, Oram C. Improved recovery from prolonged exercise following the consumption of low glycemic index carbohydrate meals. Int J Sport Nutr Exerc Metab 2005 Aug;15(4):333-49.

(6) Stevenson E, Williams C, Nute M, Swaile P, Tsui M. The effect of the glycemic index of an evening meal on the metabolic responses to a standard high glycemic index breakfast and subsequent exercise in men. Int J Sport Nutr Exerc Metab 2005 Jun;15(3):308-22.

(7) Stevenson E, Williams C, Nute M. The influence of the glycaemic index of breakfast and lunch on substrate utilisation during the postprandial periods and subsequent exercise. Br J Nutr 2005 Jun;93(6):885-93.

(8) Trenell MI, Stevenson E, Stockmann K, Brand-Miller J. Effect of high and low glycaemic index recovery diets on intramuscular lipid oxidation during aerobic exercise. Br J Nutr 2008 Feb;99(2):326-32.

(9) Wu CL, Nicholas C, Williams C, Took A, Hardy L. The influence of high-carbohydrate meals with different glycaemic indices on substrate utilisation during subsequent exercise. Br J Nutr 2003 Dec;90(6):1049-56.

(10) DeMarco HM, Sucher KP, Cisar CJ, Butterfield GE. Pre-exercise carbohydrate meals: application of glycemic index. Med Sci Sports Exerc 1999 Jan;31(1):164-70.

(11) Thomas DE, Brotherhood JR, Miller JB. Plasma glucose levels after prolonged strenuous exercise correlate inversely with glycemic response to food consumed before exercise. Int J Sport Nutr 1994 Dec;4(4):361-73.

(12) Thomas DE, Brotherhood JR, Brand JC. Carbohydrate feeding before exercise: effect of glycemic index. Int J Sports Med 1991 Apr;12(2):180-6.

(13) Moore LJ, Midgley AW, Thurlow S, Thomas G, Mc Naughton LR. Effect of the glycaemic index of a pre-exercise meal on metabolism and cycling time trial performance. J Sci Med Sport 2010 Jan;13(1):182-8.

(14) Moore LJ, Midgley AW, Thomas G, Thurlow S, McNaughton LR. The effects of low- and high-glycemic index meals on time trial performance. Int J Sports Physiol Perform 2009 Sep;4(3):331-44.

(15) Cheng IS, Liao SF, Liu KL, Liu HY, Wu CL, Huang CY, et al. Effect of dietary glycemic index on substrate transporter gene expression in human skeletal muscle after exercise. Eur J Clin Nutr 2009 Dec;63(12):1404-10.

(16) Mondazzi L, Arcelli E. Glycemic index in sport nutrition. J Am Coll Nutr 2009 Aug;28 Suppl:455S-463S.:455S-63S.

(17) Stevenson EJ, Thelwall PE, Thomas K, Smith F, Brand-Miller J, Trenell MI. Dietary glycemic index influences lipid oxidation but not muscle or liver glycogen oxidation during exercise. Am J Physiol Endocrinol Metab 2009 May;296(5):E1140-E1147.

(18) Nabb SL, Benton D. The effect of the interaction between glucose tolerance and breakfasts varying in carbohydrate and fibre on mood and cognition. Nutr Neurosci 2006 Jun;9(3-4):161-8.

(19) Benton D, Nabb S. Carbohydrate, memory, and mood. Nutr Rev 2003 May;61(5 Pt 2):S61-S67.

(20) Benton D, Ruffin MP, Lassel T, Nabb S, Messaoudi M, Vinoy S, et al. The delivery rate of dietary carbohydrates affects cognitive performance in both rats and humans. Psychopharmacology (Berl) 2003 Feb;166(1):86-90.

(21) Benton D, Maconie A, Williams C. The influence of the glycaemic load of breakfast on the behaviour of children in school. Physiol Behav 2007 Nov 23;92(4):717-24.

(22) Benton D. Carbohydrate ingestion, blood glucose and mood. Neurosci Biobehav Rev 2002 May;26(3):293-308.

(23) Papanikolaou Y, Palmer H, Binns MA, Jenkins DJ, Greenwood CE. Better cognitive performance following a low-glycaemic-index compared with a high-glycaemic-index carbohydrate meal in adults with type 2 diabetes. Diabetologia 2006 May;49(5):855-62.

(24) Ingwersen J, Defeyter MA, Kennedy DO, Wesnes KA, Scholey AB. A low glycaemic index breakfast cereal preferentially prevents children's cognitive performance from declining throughout the morning. Appetite 2007 Jul;49(1):240-4.

(25) Micha R, Rogers PJ, Nelson M. The glycaemic potency of breakfast and cognitive function in school children. Eur J Clin Nutr 2010 Sep;64(9):948-57.

(26) Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. Physiol Behav 2005 Aug 7;85(5):635-45.