Glycemic Load Vs. Glycemic Index

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Introduction

Carbohydrates play a key role in athletic performance - particularly as an energy source. Carbohydrate, in the form of glucose, does not only fuel active skeletal muscle, but it is also a metabolic fuel for nerve cells and red blood (1). Elite athletes and exercise physiologists do not solely view carbohydrates as a fuel source, but also study the effects that carbohydrates have on physique/body composition. Because of advances in nutritional biochemistry, it has been learned that various types of carbohydrates affect the body differently. Amazingly, some types of carbohydrates are preferentially converted to fat, raise blood glucose levels to high physiologic levels, and are linked to health problems such as diabetes, obesity, cancer, etc. (2,3,6,9). Other types of carbohydrates, such as disaccharides and polysaccharides, are not converted to fat easily and are not considered to be deterrents to good health. Relative to dietary carbohydrate, this article will discuss the differences between the glycemic index and the glycemic load. Because of its practical application relative to food intake, professionals in the human performance industry should consider the glycemic load of a food when designing meals, planning recovery nutrition, and creating specialized diets to enhance body composition.

The Glycemic Index

The glycemic index was developed by researchers from the University of Toronto approximately thirty years ago, and was primarily used as a tool for diabetics looking to control their blood glucose (blood sugar) levels (7). Today, many other non-diabetic individuals are also using this index as a way to choose foods to eat for health, weight loss and performance. Relative to weight loss, several scientific studies have been conducted with the primary intervention being the glycemic index values of various diets (4,10,11). Specifically, the glycemic index is a numerical ranking of carbohydrate-containing foods based on their potential to raise blood sugar levels. Carbohydrates that are high on the glycemic index (>70) are quickly digested and absorbed. These carbohydrates tend to cause a rapid rise in blood glucose and in most cases a quick rise in insulin. Conversely, carbohydrates that are low on the glycemic index (~55 and below) are more slowly absorbed and subsequently cause a relatively small increase in blood sugar and insulin. Hence, the glycemic index allows an individual to indirectly estimate both blood glucose and insulin levels which is not only important for diabetics, but is also important for anyone looking to control body weight or when determining what type of carbohydrates to ingest prior to and following exercise bouts.

Determining the Glycemic Index of a Food

Researchers measure out a portion of food that contains 50 grams of carbohydrate. For instance, 4 slices of bread, 1 1/4 cups of rice, 1 1/2 pounds of carrots, and 2 medium apples each contains about 50 grams of available carbohydrate. A food is fed to a group of test subjects and their blood sugar responses are measured. The test subjects' blood sugar response to the food is then compared with their response to eating 50 grams (about 3 tablespoons) of pure glucose. To illustrate this point, oatmeal will be used as an example. Oatmeal on average is approximately 49 on the glycemic index. When plain oatmeal that contains 50 grams of carbohydrate is eaten, it will produce an increase in blood sugar approximately 49% of that obtained when the same amount (i.e. 50 grams) of straight glucose is consumed.

Foods That Have a High Glycemic Index

Generally speaking, foods that rank high on the glycemic index include products made from finely ground flours like bread and baked goods; processed breakfast cereals (Corn Flakes®); candy (i.e., jelly beans), and baked, mashed, and French fried potatoes (5). Foods that rank lower on the glycemic index include most vegetables and fruits; sweet potatoes; legumes; minimally processed whole grains such as thick-cut oatmeal, oat bran, barley, pasta; and dairy products (5). The following table lists some common foods and their glycemic index.

Table 1. Common foods and their glycemic index scores		
High Glycemic Index (>70)	**Moderate Glycemic Index (70-56)**	**Low Glycemic Index (<55)**
Boiled potato – 101	Croissant – 67	Wheat Bread – 53
Baked Potato – 85	Brown rice – 66	Potato chips – 51
Pretzels – 83	Whole meal bread – 65	Peas – 51
Corn flakes – 80	Oreo cookies – 64	White pasta – 50
Gatorade – 78	Raisins – 64	Apple juice – 40
Shredded wheat – 75	Ice cream – 61	Oranges – 40
Cheerios – 74	Raisin Bran – 61	Skim milk – 32
Bagel – 72	Sucrose – 59	Whole milk – 27
Watermelon – 72	Coca-Cola – 58	Fructose – 20
White rice – 72	Fruit cocktail – 55	Peanuts – 13

Glycemic Index vs. Glycemic Load

The glycemic index is not the only tool that can be used to determine the blood glucose response to a particular food item. The glycemic load uses the glycemic index as well as the actual amount of carbohydrate (i.e. the serving size) to determine the overall effect that a carbohydrate-containing food has on blood sugar and subsequent insulin values. As mentioned earlier, the glycemic index compares different food sources that contain carbohydrates of the same quantity (i.e. 50 grams of glucose is compared to 50 grams of carbohydrate in oatmeal). However, this is not always practical or realistic because many foods are not consumed in 50 gram (1.76 ounces) portions. The glycemic load is calculated by multiplying the amount of carbohydrate in a given serving of food by the glycemic index of that same food and then dividing that number by 100. For example, a boiled potato has a glycemic index of ~101 and a Mars® candy bar has a glycemic index of ~65. However, the average serving size of a baked potato is about 150 grams (5.3 oz) and contains 17 grams of carbohydrate. Conversely, a Mars® candy bar serving size is only 60 grams (2.1 oz) but contains 40 grams of carbohydrate. The boiled potato has a glycemic load of 17, while the Mars bar is 26. Thus, even though the potato has a higher glycemic index, the Mars® candy bar has a greater effect on blood glucose than the potato even though the size of the Mars® candy bar is less than half that of the potato. Dr. Jeukendrup, a respected sports nutrition researcher, reports that foods with a glycemic load of > 20 are high, 11-19 are medium, and < 10 are low (8). The following table lists some common foods with their corresponding glycemic index and glycemic loads.

Table 2. Comparison of glycemic index and glycemic load for common foods			
Food	**Glycemic Index**	**Carbohydrates (g)**	**Glycemic Load**
1 medium carrot	71	8	6
1 cup watermelon	72	11	8
1 cup brown rice	55	44	24
1 cup pasta	41	39	16
12-oz soda	68	37	25

Conclusion

While both the glycemic index and the glycemic load provide information relative to the impact that carbohydrates have on the blood sugar and subsequent insulin response, the glycemic load is a more practical scale for reasons mentioned above. It is also important to realize that both glycemic index and glycemic load only refer to the food eaten alone. When fat or protein from other foods are added to a meal containing carbohydrates, the total impact of either score goes down. In conclusion, since carbohydrate intake and its effects on the blood glucose/insulin response are important for the hard training athlete, one should consider utilizing the glycemic load to assist in making carbohydrate food choices.

References

1. Stipanuk MH. *Biochemical and Physiological Aspects of Human Nutrition*. W.B. Saunders Company, Philadelphia, PA. 2000.

2. Augustin LS, Dal Maso L, La Vecchia C, Parpinel M, Negri E, Vaccarella S, Kendall CW, Jenkins DJ, Francesch S. Dietary glycemic index and glycemic load, and breast cancer risk: a case-control study. *Annals of Oncology*, 12(11): 1533 – 1538, 2001.

3. Barkoukis H, Marchetti CM, Nolan B, Sistrun SN, Krishnan RK, Kirwan JP. A high glycemic meal suppresses the postprandial leptin response in normal healthy adults. *Annals of Nutrition & Metabolism*, 51(6):512 – 518, 2007.

4. Das SK, Gilhooly CH, Golden JK, Pittas AG, Fuss PJ, Cheatham RA, Tyler S, Tsay M, McCrory MA, Lichtenstein AH, Dallal GE, Dutta C, Bhapkar MV, Delany JP, Saltzman E, and Roberts SB. Long-term effects of 2 energy-restricted diets differing in glycemic load on dietary adherence, body composition, and metabolism in CALERIE: a 1-y randomized controlled trial. *American Journal of Clinical Nutrition*, 85(4):1023 – 1030, 2007.

5. Foster-Powell K, Holt S, and Brand-Miller J. International table of glycemic index and glycemic load values: 2002. *American Journal of Clinical Nutrition*, 76:5 – 56, 2002.

6. Franceschi S, Dal Maso L, Augustin L, Negri E, Parpinel M, Boyle P, Jenkins DJ, and La Vecchia C. Dietary glycemic load and colorectal cancer risk. *Annals of Oncology*, 12(2):173 – 178, 2001.

7. Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, Baldwin JM, Bowling AC, Newman HC, Jenkins AL, Goff DV. Glycemic index of foods: a physiological basis for carbohydrate exchange. *American Journal of Clinical Nutrition*, 34(3):362 – 6, 1981

8. Juekendrup A and Gleeson M. *Sports Nutrition: An Introduction to energy Production and Performance*. Human Kinetics. 2004.

9. Radulian G, Rusu E, Dragomir A, Posea M. Metabolic effects of low glycaemic index diets. *Nutrition Journal*, 29;8:5, 2009.

10. Sichieri R., Moura AS, Genelhu V, Hu F, and Willett WC. An 18-mo randomized trial of a low-glycemic-index diet and weight change in Brazilian women. *American Journal of Clinical Nutrition*, 86(3):707 – 713, 2007.

11. Sloth B, Krog-Mikkelsen I, Flint A, Tetens I, Bjorck I, Vinoy S, Elmstahl H, Astrup A, Lang V, and Raben A. No difference in body weight decrease between a low-glycemic-index and a high-glycemic-index diet but reduced LDL cholesterol after 10-wk ad libitum intake of the low-glycemic-index diet. *American Journal of Clinical Nutrition*, 80(2):337 – 347, 2004.