3-2002

Glycemic Index of Popular Sport Drinks and Energy Foods

Randall J. Gretebeck
Marquette University, randall.gretebeck@marquette.edu

Kimberlee A. Gretebeck
Marquette University, kimberlee.gretebeck@marquette.edu

Thomas J. Tittelbach
University of Maryland - Baltimore

Journal of the American Dietetic Association, Vol. 102, No. 3 (March 2002): 415-417. DOI.

Glycemic Index of Popular Sport Drinks and Energy Foods

Randall J. Gretebeck
Division of Health, Physical Education, and Recreation, College of Education, Wayne State University, Detroit, MI
Kimberlee A. Gretebeck
Department of Nursing, University of Michigan, Ann Arbor, MI
Thomas J. Tittelbach
Division of Gerontology at University of Maryland, Baltimore, MD

Carbohydrate consumption before or during prolonged exercise can enhance endurance performance and after exercise can enhance restoration of glycogen stores (1). For these reasons, athletes are typically advised to increase carbohydrate intake before, during, and after exercise. The type of carbohydrate has recently been included in these recommendations, with the glycemic index used to characterize the blood glucose response to various carbohydrate-containing foods.

The concept of the glycemic index was introduced by Jenkins et al (2) in 1981 as a way of ranking foods on the actual postprandial blood glucose response, compared with a reference food—either glucose or white bread. The glycemic index is calculated by measuring the incremental area under the blood glucose curve, following ingestion of a test food providing 50 g carbohydrate, compared with the area under the blood glucose curve,

following an equal carbohydrate intake from the reference food, with all tests being conducted after an overnight fast:

$$\text{Glycemic index} = \frac{\text{Blood glucose area after test food}}{\text{Blood glucose area after reference food}} \times 100$$

Using the glycemic index, or comparison to a reference food, addresses the considerable interindividual variability in the absolute glycemic response to foods. Tables on the measured glycemic index of various carbohydrate-rich foods have been published (3); the benefits of using glycemic index to counsel people remains in debate (4).

The provision of blood glucose to fuel performance during exercise and restore glycogen reserves after exercise is a concern for athletes. In addition, athletes may have difficulty consuming mixed meals or several different food items during or immediately after exercise. Indeed, a number of diet plans and food supplements have been designed for athletes specifically to spare glycogen during exercise and restore glycogen after exercise. In general, low glycemic index carbohydrate foods have been recommended for consumption before prolonged exercise to promote carbohydrate availability. Moderate to high glycemic index carbohydrate foods and drinks are considered appropriate during prolonged exercise (5). High glycemic index carbohydrates are considered the best choice to enhance glycogen storage after exercise by promoting greater glucose and insulin responses.

Although some of these recommendations are debated (5) and further investigation is needed, these recommendations have already been incorporated into some sport nutrition guidelines. Unfortunately, these guidelines can be difficult for athletes to follow, simply because the glycemic index for foods specifically designed for and often used by athletes before, during, and after training and competition have not been measured. Therefore, the purpose of this investigation was to measure the glycemic index of some foods specifically marketed to or used by athletes before, during, and after exercise. We considered 3 categories of sport foods: sport drinks, energy bars, and meal-replacement drinks.

METHODS

Subjects

The majority of glycemic index studies use 5 to 7 subjects (3). For this study, 5 apparently healthy adult subjects (3 men and 2 women who were recreationally active and reported no health problems) volunteered to participate after approval by the Human Subjects Review Committee at Purdue University, West Lafayette, Indiana.

Measurements

Glycemic index was measured according to Wolever et al (6). Originally, the glycemic index was based on a 50-g glucose solution as the standard (the glycemic index of glucose=100) (2). White bread may also be used as the standard; however, much of the research concerning carbohydrates and athletic performance is based on the use of glucose solutions 7, 8, 9, and most of the sport foods used by athletes are in liquid form. Thus, we defined the glycemic response of glucose as 100, which can be converted to the white bread standard by multiplying by 1.34 (6).

Each subject completed 3 tests using glucose as the reference food, with the mean result being used as the reference to calculate the glycemic index values of the test foods, which were each tested once in random order by all subjects (6). Blood glucose was measured on whole capillary blood samples using One Touch blood glucose meters checked for accuracy using high, low, and normal test solutions available from the manufacturer (Lifescan Inc, Milpitas, Calif.). After an overnight fast, blood glucose was measured at 0,15,30,45,60,90, and 120 minutes after the start of consuming the test food. However, if subjects returned to baseline or below

baseline before 2 hours, blood sampling was discontinued and the time of return to baseline was determined by interpolation according to Wolever (6). Results were compared with glucose with *t* tests using the Bonferroni adjustment for multiple comparisons (10). The foods and amounts that were tested are shown in the Table.

Table. Food products consumed and glycemic index (mean±standard deviation) for 5 recreationally active adults

Product (flavor)	**Total weight consumed (g)**	**Carbohydrate (g)**	**Protein (g)**	**Fat (g)**	**Energy(kcal)**	**Glycemic index**	***P* value***
Glucose solution	355	50	0	0	200	100	
Sport drinks							
GatorLode[a] (Orange)	243	50	0	0	200	100±21	0.601
Gatorade[a] (Orange)	858	50	0	0	200	89±27	0.479
XLR8[b] (Orange)	955	50	0	0	200	68±15	0.010
Poweraid[c] (Orange)	633	50	0	0	200	65±11	0.004*
Cytomax[d] (Orange)	1,183	50	0	0	250	62±15	0.007*
Allsport[e] (Orange)	591	50	0	0	200	53±9	0.000*
Energy bars							
Cliff bar[f] (Cookies & Cream)	67	50	13	4	290	101 ±27	0.998
Power bar[g] (Chocolate)	72	50	11	2	256	83±25	0.256
PR-bar[h] (Cookies 'N Cream)	118	50	33	17	478	81 ±26	0.195
MET-Rx bar[i] (Vanilla)	100	50	28	3	340	74±26	0.132
Meal replacements							
GatorPro[a] (Chocolate)	275	50	14	5	304	89±18	0.961
Optifuel[h]	355	50	10	0	240	78±18	0.070
Ensure® (Vanilla)	283	50	11	7	310	75±23	0.098
Boost High Protein[k] (Vanilla)	343	50	23	9	360	59±20	0.015
MET-Rx[j] (Vanilla)	1,242	50	84	5	632	58±36	0.082
Boost[k] (Vanilla)	283	50	12	5	300	53±9	0.000*

*Significantly lower than glucose (*P*<05) using f tests with Bonferroni adjustment for multiple comparisons (Godfrey KAM. *N EnglJ Med.* 1985; 13:1450-1456).

[a]Gatorade, Chicago, III.

[b]Softpac Industries Inc., Plymouth, Minn.

[c]Coca-Cola Company, Atlanta, Ga.

[d]Cytosport, Concordia, Calif.

[e]PepsiCo Inc., Somers, NY.

[f]Cliff bar Inc., Berkeley, Calif.

[g]Power bar Inc., Berkeley, Calif.

[h]Twin Laboratories Inc., Ronkonkowa, NY.

[i]Met=Rx Sibstrate Technology Inc., Irvine, Calif.

[j]Abbott Laboratories, Columbus, Ohio.

[k]MeadJohnson, Evansville, Ind.

Results and Discussion

Results showing the glycemic index for food products in each category are shown in the Table. The glycemic index may have an important role in athletic performance where the depletion of endogenous carbohydrate is a limiting factor (11); yet, the glycemic index for sport nutrition commercial products has not been readily available. This investigation shows that there is a wide range in glycemic index for sport drinks, energy bars, and

meal-replacement drinks. There are a number of attributes of carbohydrate-rich foods that may be of value to athletes including the nutritional value, palatability, portability, cost, gastric comfort, and ease of preparation. This investigation provides an additional piece of information allowing athletes to make more informed choices.

A general indication of the type of carbohydrate in these products is found on the product labels. The most common ingredient was high fructose corn syrup. Major ingredients are listed in descending order on product labels—high fructose corn syrup was the first ingredient listed in some products and appeared much further down the ingredient list for other products. However, the amount of actual fructose in the high fructose corn syrup could not be discerned from the label. Thus, the label on the products did not necessarily provide a good indication of the glycemic response caused by these products. The published glycemic index for fructose is 23 (3), which is lower than all the products tested. The concentration of carbohydrates in the sport drinks evaluated in this investigation ranged from 4% to 20%, and the resulting volumes ingested to provide 50 g carbohydrate ranged from 0.24 to 1.18 L (Table). The American College of Sports Medicine recommends that carbohydrates should be ingested throughout exercise at a rate of 30 to 60 g h^{-1}, keeping the carbohydrate concentration below 10% (g.100 ml^{-1} of fluid). Thus, the carbohydrate concentration of some products conformed more closely to guidelines for use during exercise than others. Indeed, one product in particular (Gatorlode; Gatorade, Chicago, Ill.) is not intended or marketed for use during exercise but rather for use after exercise to replenish glycogen stores.

The energy contents of the sport drinks tested were relatively similar. The energy bars varied dramatically in energy content (Table) because of the variable amounts of protein and fat. This produced much more variability in the glycemic response. Coleman et al (12) has concluded that liquid and solid carbohydrate feedings consumed during exercise are equally effective in increasing blood glucose and improving performance and also similarly effective in promoting glycogen repletion following exercise. This study showed that the glycemic index of the energy bars did not significantly differ from glucose (P<0.05) even though they varied widely in energy content based on the 50-g carbohydrate requirement for measuring glycemic index.

Meal-replacement drinks were included in this investigation because they are used increasingly by athletes to supplement a regular diet. These products showed the widest range in the peak glucose response (mean values ranged from a low of 4.7 to a high of 7.3 mmol/L^1 for Met-Rx and Optifuel, respectively) but not in glycemic index, which points to a possible shortcoming in the use of the glycemic index for athletes. The classification of foods according to their glycemic index does not consider the insulin response, which has large effects on metabolism and is functionally significant because it regulates glucose disposal. Therefore, the classification of foods according to their glycemic index is recognized to be rather simplistic. However, its functional significance for describing the metabolic effects of carbohydrate ingestion is certainly better than the prevalent classification of simple or complex carbohydrate. This is especially important for athletes who use sport nutrition commercial products to improve performance or aid in recovery.

Applications

The glycemic index provides a relatively new form of nutrition information that some educators have already incorporated into dietary advice for athletes (5). The purpose of this study was to meet the needs of sport nutrition professionals who use commercial products and wish to incorporate the use of glycemic index in their dietary advice for athletes. They cannot do so if they do not know what the glycemic index is. Food labels list the amount of carbohydrate in products, but the amounts of each type of carbohydrate can only be indirectly inferred from a descending list of ingredients by weight. As these results show, products with similar ingredients on their labels can produce a markedly different glycemic index.

This research was supported in part by a grant to R. J. Gretebeck from the Gatorade Sports Science Institute, PO Box 75886, Chicago, IL 60675-5886.

References

1 American College of Sports Medicine Position Stand on Exercise and Fluid Replacement. *Med Sci Sports Exerc*. 1996;28:i-vii.

2D.J.A. Jenkins, I.M.S. Wolever, R.H. Taylor, H. Barker, H. Fieldman, J.M. Baldwin, A.C. Bowling, H.C. Newman, A. L. Jenkins, D.V. Goff. **Gylcemic index of foods: A physiological basis for carbohydrate exchange.** *Am J Clin Nutr*., 34 (1981), pp. 362-366

3 K. Foster-Powell, J. Brand Miller. **International tables of glycemic index.** *Am J Clin Nutr*., 62 (su) (1995), pp. 871S-893S

4 T.M.S. Wolever. **The glycemic index: flogging a dead horse?** *Diabetes Care*., 20 (1997), pp. 452-456

5 L.M. Burke, R.C. Gregory, M. Hargreaves. **Glycemic Index—A new tool in sport nutrition?** *Int J Sport Nutr*., 8 (1998), pp. 401-415

6 T.M.S. Wolever, D.J.A. Jenkins, A.L. Jenkins, R.G. Josse. **The glycemic index: methodology and clinical implications.** *Am J Clin Nutr*., 54 (1991), pp. 846-854

7 E.F. Coyle. **Substrate utilization during exercise in active people.** *Am J Clin Nutr*., 61 (suppl) (1995), pp. 968S-979S

8 W.L. Mason, G. McConell, M. Hargreaves. **Carbohydrate ingestion during exercise: Liquid vs solid feedings.** *Med Sci Sports Exerc*., 25 (1993), pp. 966-969

9 W.H.M. Saris, B.H. Goodpaster, A.E. Jeukendrup, F. Brouns, D. Halliday, A.J.M. Wagenmakers. **Exogenous carbohydrate oxidation from different carbohydrate sources during exercise.** *J Appl Physiol*., 75 (1993), pp. 2168-2172

10 K.A.M. Godfrey. **Statistics in practice: comparing the means of several groups.** *N Engl J Med*., 313 (1985), pp. 1450-1456

11 P. Walton, E.C. Rhodes. **Glycemic index and optimal performance.** *Sports Med*., 23 (1997), pp. 164-172

12 E. Coleman. **Update on carbohydrate: solid versus liquid.** *Int J Sport Nutr*., 4 (1994), pp. 80-88

[1]To convert mmol/L glucose to mg/dL, multi-ply mmol/L by 18.0. To convert mg/dL glucose to mmol/L, multiply mg/dL by 0.0555. Glucose of 6.0mmol/L=108mg/dL.