



# SPORTS SCIENCE EXCHANGE

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## EATING ON THE ROAD: WHERE ARE THE CARBOHYDRATES?

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### INTRODUCTION

Obtaining a nutritious high-carbohydrate meal while traveling can be a challenge for athletes. For many teams, meal stops are often made at fast-food restaurants because they are convenient, relatively inexpensive, and appealing to athletes. Although the athletes' hunger may be satisfied, what about their nutritional status? Did they eat enough carbohydrates to replenish their glycogen stores? Did they consume too much fat? What about vitamins and minerals? Did they drink enough to restore normal hydration? No matter where athletes are traveling to compete, it is important that they choose the proper fuel for optimal performance. In this article, choosing meals that provide ample amounts of carbohydrates is the primary challenge.

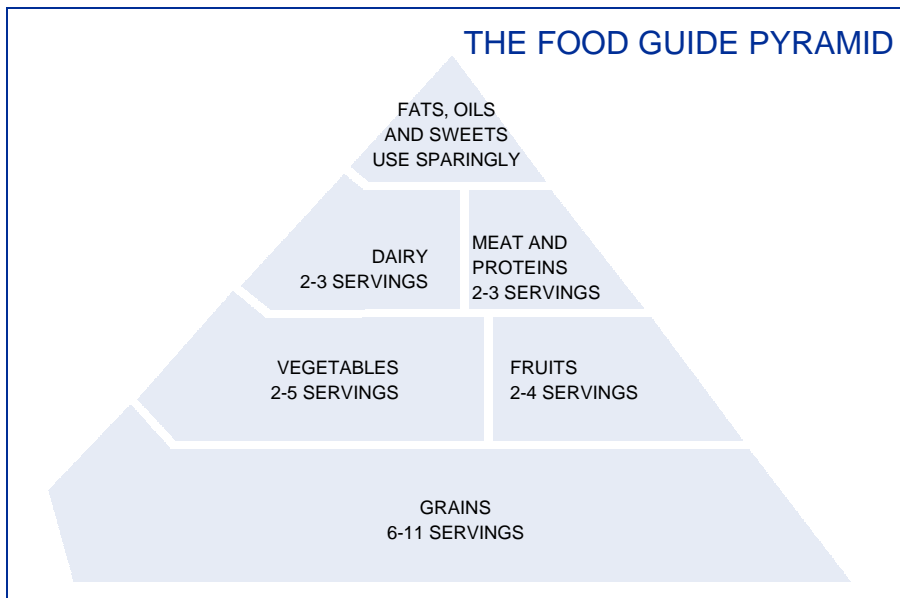
### RESEARCH REVIEW

The availability of carbohydrate stores (muscle and liver glycogen and blood glucose) plays a critical role in athletic performance (Coleman, 1998; Coleman and Steen, 1996). Strenuous physical activity requires rapid production of ATP at rates that can only be met by carbohydrate metabolism. Neither fat nor protein can be oxidized rapidly enough to meet the demands of high-intensity exercise. Adequate dietary carbohydrate must be consumed on a daily basis to restore glycogen levels.

Endurance athletes who train exhaustively on successive days must consume adequate carbohydrate and energy to minimize the threat of fatigue associated with the cumulative effects of muscle glycogen depletion. Costill et al (1981) evaluated glycogen synthesis on a 45%-carbohydrate diet during three successive days of running 16.1 K at 80%  $\text{VO}_2\text{max}$ . Initial muscle glycogen levels were 110 mmol / kg and fell to 88 mmol / kg on day two and 66 mmol / kg on day three. When runners were provided with additional dietary carbohydrate (525 to 648 g per day), glycogen synthesis was promoted, and resulted in near maximal repletion of muscle glycogen within 24 hours.

Unfortunately, athletes may not voluntarily increase caloric intake to meet the energy demands of increased training. Costill et al (1988) studied the effects of 10 days of increased training volume at a high intensity on muscle glycogen and swimming performance. While six swimmers self-selected a daily diet containing 4,700 calories / day and 8.2 gm of carbohydrate / kg / day, four swimmers self-selected a diet containing only 3,700 calories / day and 5.3 gm of carbohydrate / kg / day. The four swimmers on the lower-calorie and carbohydrate diet were unable to tolerate the heavy training demands and swam at significantly slower speeds, presumably due to a 20% decline in muscle glycogen.

In addition to endurance exercise, glycogen depletion can occur during training in sports that involve high-power, intermittent efforts, but careful attention to dietary choices can prevent this. For example, compared to the effects of low carbohydrate diets, a high carbohydrate diet will help maintain muscle glycogen stores in hockey players (Akermark et al), and will increase sprinting capacity in those performing efforts similar to those in soccer and football (Nicholas et al, 1997; Bangsbo et al, 1992). Nicholas et al (1997) recently demonstrated this by manipulating the diet during a 22-hour recovery period between performance tests that simulated the activities of soccer. Six males received either a control diet (C) or the carbohydrate (CHO) diet. Before and after the diets, subjects performed a shuttle run test that culminated in a shuttle



run (alternating between 55% and 95% of peak oxygen uptake) until fatigue. During the 22-hour recovery period, the carbohydrate intake of CHO group was increased from 5.4 g / kg body weight to 10 g / kg body weight. An isocaloric diet, which contained additional energy in the form of fat and protein, was given as the control treatment. In the second run test, the CHO treatment increased the time to fatigue by over 3 min whereas the control diet of less carbohydrate decreased time to fatigue by almost 3 min.

The message from these studies is clear – not only a high carbohydrate diet is needed, but extra carbohydrate is beneficial as well. The fatigue and poor performance associated with glycogen depletion can be prevented by a carbohydrate-rich diet (6-10 gm / kg / day) and with periodic rest days to give the muscles time to replenish the glycogen. The typical American diet (46% carbohydrate - usually about 4 gm / kg) does not supply enough carbohydrate for most athletes (USDA and DHH, 1995). A diet containing 8 to 10 g of carbohydrate per kg body weight (3.6-4.5 g / lb) is recommended when the athlete is training hard (e.g., 70% of  $\dot{V}O_{2max}$  for more than one hour). Endurance athletes in heavy training will need to reduce fat intake to about 20-25% of total calories to obtain 8-10 gm of carbohydrate / kg / day (Saris et al, 1989). Athletes participating in ultra-endurance events lasting over four hours have even greater energy and carbohydrate requirements. Saris and colleagues (1989) studied food intake and energy expenditure during the Tour de France (22 day, 2,400 mile race) and found that these cyclists consumed an average of 850 gm of carbohydrate per day (12.3 gm / kg / day). To achieve this intake, the

cyclists ingested high-carbohydrate beverages in volumes that comprised 30% of total calories.

These guidelines for carbohydrate intake assume that the athlete is consuming adequate energy on a daily basis. Athletes who consume low-energy diets will slow the depletion of muscle and liver glycogen stores. This will lead to fatigue, and may impair training and performance. Low-energy diets are prevalent among athletes such as gymnasts, figure skaters, wrestlers, and other athletes who traditionally maintain low body weights for appearance or performance. However, even during weight loss and energy restriction, a diet high in carbohydrate appears to

be beneficial in helping athletes maintain high-intensity performance capacity (Walberg et al, 1989; Horswill et al, 1990; McMurray et al, 1991).

**PRACTICAL APPLICATIONS**

Athletic trainers and coaches will need to encourage adequate intake and guide athletes in food choices, especially on the road. Each athlete's specific energy requirements will depend on weight, height, age, gender, and metabolic rate, and on the type, intensity, frequency, and duration of training. The food guide pyramid offers a visual and practical method for selecting a nutritionally balanced training diet that provides adequate energy and carbohydrate (USDA and DHHS, 1992).

Foods are classified according to their nutrient content. The breads, cereal, rice and pasta group supplies foods high in carbohydrates, iron, niacin, thiamin and fiber; the fruit and the vegetable groups supply vitamins A and C, and carbohydrates; the meat group provides protein, thiamin, iron and zinc; and the milk group is high in calcium, riboflavin and protein. By eating a variety of foods from each group, the athlete will obtain necessary nutrients for both health and exercise. Athletes should focus on boosting carbohydrate intake by consuming additional servings from the bread, fruit, and vegetable groups.

When traveling, it helps to determine in advance where the team will eat to assure that a high-carbohydrate meal will be available. Restaurant managers are generally

Waffles with fruit and syrup Bagel Low-fat milk	Chili with beans Rice Lemonade Sherbert
Cereal with banana and granola Whole wheat toast with jam Orange juice	Grilled chicken sandwich Baked potato Iced Tea Frozen fruit bar
Roast beef sandwich on whole grain roll with tomato and lettuce Applesauce Fruit juice Low-fat vanilla milkshake	Pizza with mushrooms Salad with veggies Breadsticks Soft drink
Spaghetti with tomato sauce Garlic bread Garden veggie salad Low-fat frozen yogurt Low-fat milk	Chicken on Romaine salad with slice apples Oatmeal raisin cookie Low-fat yogurt Soft drink
Bean burrito Low-fat chips and salsa Lemonade	Turkey sub Low-fat chips Apple Sports drink
Pasta with vegetables Italian roll Strawberries Iced tea	Rice with vegetables and black beans Garden veggie salad Fruit cup Low-fat milk

accommodating, especially if notified in advance. When staying in a hotel that offers food service, the catering manager can be contacted to ask for high-carbohydrate meals that fit within the budget. Examples of high-carbohydrate breakfasts include pancakes / waffles with fruit, or hot cereal with muffins, fruit juice, and low-fat milk. Lunch could consist of a chicken sandwich on whole wheat bread, low-fat yogurt or ice milk, and fresh fruit. Dinner could consist of pasta with bread, salad, fruit, and low-fat milk. A number of additional examples of such meals are listed in Table 1.

#### Fast Food Strategies

Although many fast foods are high in fat and relatively low in carbohydrate, micronutrients, and fiber, many franchises now offer low-fat, nutritious choices (Coleman and Steen, 1996). Athletes can use the general guidelines in Table 2 to make food choices. Most fast-food restaurants and many traditional restaurants now provide literature on the nutritional content of their offerings. The details may be posted or may be requested, and the coach and athletic trainer are encouraged to obtain this information.

Breakfast is a good occasion for a fast food meal because there is usually a wide selection of high-carbohydrate foods—cereal (hot and cold), bagels, muffins, pancakes, toast, fruit and fruit juices. For example, at McDonald's®, two whole English muffins with jam, 1 scrambled egg, 6 oz orange juice, and one carton of 2% milk provides 56% carbohydrate (105g) and 25% fat for a total of 747 kcal. Hot cakes with syrup, a fat-free apple bran muffin, and 6 oz orange juice total 630 kcal, and 85% of the energy is derived from carbohydrate (134g), 10% protein, and 5% fat.

Many fast-food chains also offer high-carbohydrate lunch and dinner choices. At McDonald's® or Carl's Jr.®, a barbecued chicken sandwich, a side salad, 6 oz orange juice, and one carton 2% milk provide 677 kcal, of which about 50% is from carbohydrate (84g) and 25% from fat. Compare this to a McDonald's Big Mac®, which supplies 560 kcal, of which 52% is from fat and only 30% is from carbohydrate (42g). A small order of fries adds 220 kcal, 49% of which is from fat. Combine the Big Mac® and fries, and you have 780 kcal - 51% from fat.

At Wendy's®, 8 oz of chili, a plain baked potato, a side salad (with vegetables and ¼ cup cottage cheese), and a small Frosty® offer 1,016 kcal, of which about 57% is from carbohydrate (145g) and 25% is from fat. Baked potatoes can be substituted

LOWER FAT CHOICES	MODERATE FAT CHOICES	HIGH FAT CHOICES
Dairy Foods Low-fat milk Frozen yogurt Low-fat milk shakes	2% milk Soft-serve ice cream Milk shakes	Whole milk Hard ice cream
Starches Bagels, english muffins Pancakes, waffles Cereals Bread sticks Baked potatoes	Small order french fries Combread	Biscuit, croissant Hash browns Large order french fries Curly, cheese or other fries Pastry, pie or brownie
Salad Bar Salad Carrot, celery sticks Pasta Fresh fruit Soups, not cream-based Low-fat dressings	Chicken, tuna salad Cole slaw Macaroni/potato salad	Olives, croutons Bacon bits More than 2 tbsp. of dressing Cream-based soups
Meats/Main Dishes Chicken filet Chicken fajitas Grilled chicken sandwich Chili with beans Plain hamburgers Vegetable pizza Chicken/turkey/ham/ roast beef sandwich or sub Bean burrito	Cheeseburgers Steak sandwiches	Fried chicken Fried chicken sandwich Fried fish, fried fish sandwich Fish or chicken nuggets "Super" "deluxe" or "supreme" sandwich or burger Sausage, pepperoni, or extra cheese pizza Bacon burger Breakfast biscuits (egg with sausage or
Sauces Catsup Mustard Barbecue Sauce		Sausage, bacon  Mayonnaise Mayo-type sauces Alfredo sauce Hollandaise sauce Added butter or margarine
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for french fries, and non-fat or low-fat milk can be substituted for a shake.

Mexican food and pizza establishments can also provide high-carbohydrate, low-fat meals. For example, at Taco Bell®, two tostados (plain shell, not fried), one bean burrito, two plain tortillas, and one carton of 2%-fat milk provide a meal containing 1,040 kcal, of which about 56% is from carbohydrate (146g) and 27% is from fat.

At Pizza Hut®, one-half of a medium thin-crust cheese pizza, two bread sticks, and a glass of 2%-fat milk supply 1,126 kcal, of which about 56% is from carbohydrate (158g) and 25% is from fat. Choosing vegetable pizza toppings will increase the carbohydrate and reduce fat content of the meal.

#### Restaurant Strategies

When dining at restaurants, the menu offers many clues to the fat content of foods. Words such as

fried, crispy, breaded, scampi-style, creamed, buttery, au gratin, and gravy all suggest high fat content. Better choices are items carrying such descriptions as steamed, broiled, boiled, charbroiled, poached, marinara, tomato sauce, and "in its own juice."

#### Tips for Different Cuisine's Chinese

When dining at Chinese restaurants, choose stir-fried and steamed dishes (such as rice) with plenty of vegetables. Avoid deep-fried items (egg rolls and wontons) and high-fat foods such as spare ribs and sweet-and-sour pork or shrimp. Fried chow-mein noodles, fried rice, egg rolls and lobster sauce (made with egg yolks) are "hidden" sources of fat. Some Chinese food choices with less fat are steamed rice, chicken chow mein, chicken / beef chop suey, steamed Chinese vegetables, stir-fry with shrimp,

vegetable, chicken, Hunan tofu, hot-and-sour soup, wonton soup, and fortune cookies.

**Indian**

Foods from India feature beans, rice, grains, vegetables and bread, all of which are high in carbohydrate and low in fat. The food is often steamed, thus adding little fat. Dishes made with coconut milk and cream contain saturated fats and should be consumed in limited quantities.

**Italian**

At Italian restaurants, pasta is a good choice, but marinara sauce is recommended over Alfredo and Pesto sauces, which are high in fat. Thick-crust plain cheese or vegetable pizza is another good choice, as are salads with dressing on the side. Bread is great, but butter, margarine, or olive oil will increase the fat content. Some lower-fat Italian choices are pasta with marinara, marsala, tomato sauce, red clam sauce, chicken marsala, spinach or mushroom tortellini, minestrone soup, bread sticks, and Italian ice.

**Mexican**

At Mexican restaurants, chicken and bean burritos (not deep fried), soft tacos, and tostados are good choices. When available, pot beans or black beans can be substituted for refried beans. (Some restaurants offer refried beans that are fat-free or made with vegetable oil instead of lard—ask the server). Heated corn tortillas can be substituted for chips, and salsa can be substituted for sour cream and guacamole, which are high in fat. Mexican food choices that are lower in fat include salsa, baked tortilla chips, gazpacho soup, black, red beans, Spanish rice, fajitas, chicken or seafood tacos made with flour or corn, and refried beans made without lard.

**Grocery and Convenience Stores**

Coaches and athletes are often interested in buying high-carbohydrate, low-fat foods for all-day events such as a volleyball tournament or a track-and-field meet. Because concession stands typically offer foods that are high in fat, (e.g. nacho chips, cheese fries, and hot dogs) and typically expensive, stopping at a grocery or convenience store is a better bet.

Many supermarkets have a soup-and-salad bar. Athletes can put together a healthy salad by combining spinach and romaine lettuce with low-fat high carbohydrate choices such as carrots, tomatoes, cucumbers, celery, mushrooms, three-bean salad, assorted fruits, and low-fat cheese. Soups such as chicken / turkey noodle / rice, minestrone, vegetable, black bean, lentil,

or green pea, are healthy choices. In general, broth-based soups are preferable compared to cream based soups that supply significantly more fat.

**Snacks**

Snacks between meals can provide additional energy and carbohydrate for athletes who expand large volumes of calories during training and competition. However, snacks, even those presumed to be healthy choices, can add up fat calories that provide satiety. As a result, foods that provide carbohydrate and other critical nutrients are displaced from the athlete's diet. To prevent this, the athlete needs to select carefully the right choices and pay attention to how they are prepared.

Which snacks are high in carbohydrate and low in fat? Table 3 gives a

quick summary of options. For more information on specific snacks, read the food labels. As a general rule, a snack that contains at least 4 grams of carbohydrate for every one gram of fat will fall into the category of being high in carbohydrates, low in fat.

**Air Travel**

Air travel presents some unique challenges. The pressurization of the cabin air increases fluid losses, so dehydration can be a problem when the flight lasts several hours or longer. In fact, dehydration is thought to contribute to jetlag. Consuming beverages containing alcohol and caffeine increases the risk of dehydration because of the diuretic nature of these beverages. The athlete should ingest plenty of water, sports drinks, and fruit juices

Table 3.  
**SNACKS – CHOICES FOR HIGH CARBOHYDRATE OR HIGH FAT\***

		APPROXIMATE VALUES	
		% Carbohydrate	% Fat
Chips	Potato chips	38	58
	Corn chips	43	51
	Banana chips	43	55
	Popcorn, air popped	82	10
	Pretzels	83	10
Nuts/seeds	Peanuts	15	73
	Almonds	13	83
	Sunflower	14	76
Cookies	Chocolate chip	55	41
	Oatmeal	58	38
	Fig	80	17
Bars	Candy bars		
	Snickers®	49	43
	Milky way®	66	31
	Peppermint Patty®	76	20
	Granola, fat-free	80	16
	Breakfast, fat-free	75	19
Rice cakes	75	15	
Pastries	Donut	44	55
	Danish, raspberry	49	49
Breads	Bagel	81	3
	English muffin	77	7
	Raisin bread	67	25
Dairy	Ice cream novelties		
	Dove Bar®	42	51
	Hagen Dazs® bar, low-fat	43	48
	Ice cream sandwich	62	33
	Popsicle	100	0
	Yogurt, low-fat, fruit	75	10
pudding, low-fat	62	35	
Fruit	Assorted	100	0

\*Sum of two percentages may be less than 100 due to the contribution of calories from protein

to replace fluid losses.

Airlines do not always provide low-fat meals. However, low-fat or vegetarian meals are often available when requested in advance. Athletes can also bring high-carbohydrate, low-fat snacks with them on the plane. If a meal is not provided on the plane, airport concession stands provide some healthy snacks such as soft pretzels, popcorn (without butter), bagels, fruit / vegetable plates, juice, and frozen yogurt. At most airports, family-style and fast-food restaurants are usually available.

Depending upon the destination, most athletes who travel interna-

tionally have difficulty finding enough food, and are concerned about food-borne illness (Berning 1998). Athletes who travel internationally have a 50% chance of contracting travelers' diarrhea that sometimes requires medical attention, and typically causes discomfort, concern, and dehydration. Bacterial infection of the intestinal tract occurs because of inadequate health standards for food and water in some countries, and because athletes have not had the chance to develop immunity to pathogens in regions where they are competing.

Precautionary measures can be taken to protect against disease-causing organisms not found at home. Some suggestions are to drink only bottled water (even if brushing teeth), avoid swallowing shower water, do not use ice cubes made from the local water supply, get restaurant recommendations from the US Embassy, hotel managers, and from coaches and athletes who have been in the area previously, stick to familiar foods, choose well-cooked foods, and avoid milk and milk products (because they require pasteurization and refrigeration), eat fruit that can be peeled (bananas, oranges, grapefruits, mangoes, kiwi), and avoid salads and other uncooked foods that come in

direct contact with the hands of the kitchen staff (Berning, 1998). It is advisable for the athlete or team to pack foods to take along. Suggestions for non-perishable items include:

- Bread sticks
- High-carbohydrate beverages (e.g., GatorLode®)
- Canned fruit / fruit juices, tuna, chicken, soups, baked beans
- Cold cereals
- Crackers
- Dried fruit
- Fig bars
- Granola and breakfast bars
- Nutrition beverages (e.g., GatorPro®)
- Oatmeal
- Peanut butter and jelly
- Popcorn (microwave)
- Pretzels
- Pre-packed puddings, Jell-O
- Sports drinks (e.g., Gatorade®)
- Water (bottled)

#### SUMMARY

Providing athletes with easy-to-use food guidelines will help them to choose high-performance food from almost any menu or food aisle. It takes planning and practice to find such foods at fast-food restaurants, family-style restaurants, and grocery stores, but it can be done. Air travel poses additional challenges to the athlete striving to maintain a training diet that is high in carbohydrate and fluids, moderate in protein, and low in fat. Taking the time to educate athletes about making wise food choices, combined with periodic reminders and encouragement throughout the season, will go a long way in helping assure adequate energy and carbohydrate intake.

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## YOUR CARBOHYDRATE INTAKE!

1. Find your approximate weight across the top of the chart.
2. Choose the amount of grams of carbohydrate that you need on a daily basis depending upon the intensity, frequency, and duration of your activity.

General guidelines are:

- Exercise less than an hour/d: 6g/kg
- Intense\* exercise: 1-2 hours/d: 9-10 g/kg
- Intense\* exercise: 2-4 hours/d: 9-10 g/kg
- Intense\* exercise>4 hours/d: 11-12g/kg

\* Intense exercise defined as >70% of VO<sub>2</sub>max

For example, if you weigh 60 kg and exercise intensely for 2.5 hours/day, total grams of carbohydrate needed per day are approximately 540-600 g/day.

HOW MUCH CARBOHYDRATE DO YOU NEED?											
CHO (g)	WEIGHT (kg)										
	50	55	60	65	70	75	80	85	90	95	100
6g	300	330	360	390	420	450	480	510	540	570	600
7g	350	385	420	455	490	525	560	595	630	665	700
8g	400	440	480	520	560	600	640	680	720	760	800
9g	450	495	540	585	630	675	720	765	810	855	900
10g	500	550	600	650	700	750	800	850	900	950	1000
11g	550	605	660	715	770	825	880	935	990	1045	1100
12g	600	660	720	780	840	900	960	1020	1080	1140	1200

For a listing of examples of high-carbohydrate foods, see back.

## HIGH-CARBOHYDRATE FOODS

FOOD GROUP	CALORIES	CARBOHYDRATES (GRAMS)	FOOD GROUP	CALORIES	CARBOHYDRATES (GRAMS)
Milk			Vegetables (Cont'd.)		
Low-fat (2%) milk (1 cup)	121	12	Corn (1/2 cup)	89	45
Skim milk (1 cup)	86	12	Lima beans	217	12
Chocolate milk (1 cup)	208	26	Peas, green (1/2 cup)	63	50
Pudding, any flavor (1/2 cup)	161	30	Potato (1 large)	63	12
Frozen yogurt, low-fat (1 cup)	220	34	Sweet Potato (1 large)	220	50
Fruit-flavored low-fat yogurt (1 cup)	225	42	Grain	118	28
Beans			Bagel (1)	165	31
Blackeye peas (1/2 cup)	134	22	Biscuit (1)	103	13
Pinto beans (1 cup)	235	44	White bread (1 slice)	61	12
Navy beans (1 cup)	259	48	Whole-wheat bread (1 slice)	55	11
Refried beans (1/2 cup)	142	26	Breadsticks (2 sticks)	77	15
Garbanzo beans (chickpeas) (1 cup)	269	45	Combread (1 square)	178	28
White beans (1 cup)	249	45	Cereal, ready-to-eat (1 cup)	110	24
Fruit and Vegetables			Oatmeal (1/2 cup)	66	12
Fruits			Cream of rice (1/4 cup)	95	21
Apple (1 medium)	81	21	Cream of wheat (1/4 cup)	96	20
Apple juice (1 cup)	111	28	Flavored oatmeal, Quaker instant (1 packet)	110	25
Applesauce (1 cup)	232	60	Graham crackers (2 squares)	60	11
Banana (1)	105	27	Saltines (5 crackers)	60	10
Cantaloupe (1 cup)	57	14	Triscuit crackers (3 crackers)	60	10
Dates, dried (10)	228	61	Pancake (4-inch diameter)	61	9
Fruit roll-ups (1 roll)	50	12	Waffles (2, 3.5" x 5.5")	130	17
Grapes (1 cup)	114	28	Rice (1 cup)	223	50
Grape juice (1 cup)	96	23	Rice, brown (1 cup)	232	50
Orange (1)	65	16	Hamburger bun (1)	119	21
Orange juice (1)	112	26	Hotdog bun (1)	119	21
Pear (1)	98	25	Noodles, spaghetti (1 cup)	159	34
Pineapple (1 cup)	77	19	Flour tortilla (1)	85	15
Prunes, dried (10)	201	53	Oatmeal raisin cookie	62	9
Raisins (2/3 cup)	302	79	Pizza (cheese, 1 slice)	290	39
Raspberries (1 cup)	61	14	Popcorn, plain (1 cup, popped)	26	6
Strawberries (1 cup)	45	11	English muffin	154	130
Watermelon (1 cup)	50	12	Fig bar (1)	50	10
Vegetables			Granola bar (low-fat, 1)	109	16
Three-bean salad (1/2 cup)	90	20	Pretzels (1 oz.)	106	21
Carrots (1 medium)	31	8			
		21			