DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

4-H Consumer Judging Guide

Nutrition for the Athlete

Quick Facts...

- Athletes achieve peak performance by training and eating a variety of foods.
- Athletes gain most from the amount of carbohydrates stored in the body.
- Fat also provides body fuel; use of fat as fuel depends on the duration of the exercise and the condition of the athlete.
- Exercise may increase the athlete's need for protein.
- Water is a critical nutrient for athletes. Dehydration can cause muscle cramping and fatigue.

Becoming an elite athlete requires good genes, good training and conditioning and a sensible diet. Optimal nutrition is essential for peak performance. Nutritional misinformation can do as much harm to the ambitious athlete as good nutrition can help.

Carbohydrates

Athletes benefit the most from the amount of carbohydrates stored in the body. In the early stages of moderate exercise, carbohydrates provide 40 to 50 percent of the energy requirement. Carbohydrates yield more energy per unit of oxygen consumed than fats. Because oxygen often is the limiting factor in long duration events, it is beneficial for the athlete to use the energy source requiring the least amount of oxygen per kilocalorie produced. As work intensity increases, carbohydrate utilization increases.

Complex carbohydrates come from foods such as spaghetti, potatoes, lasagna, cereals and other grain products. Simple carbohydrates are found in fruits, milk, honey and sugar. During digestion, the body breaks down carbohydrates into glucose and stores it in the muscles as glycogen.

During exercise, the glycogen is converted back to glucose and is used for energy. The ability to sustain prolonged vigorous exercise is directly related to initial levels of muscle glycogen. The body stores a limited amount of carbohydrate in the muscles and liver. If the event lasts for less than 90 minutes, the glycogen stored in the muscle is enough to supply the needed energy. Extra carbohydrates will not help, any more than adding gas to a half-full tank will make the car go faster.

For events that require heavy work for more than 90 minutes, a high-carbohydrate diet eaten for two to three days before the event allows glycogen storage spaces to be filled. Long distance runners, cyclists, cross-country skiers, canoe racers, swimmers and soccer players report benefits from a precompetition diet where 70 percent of the calories comes from carbohydrates.

According to the Olympic Training Center in Colorado Springs, endurance athletes on a high-carbohydrate diet can exercise longer than athletes eating a low-carbohydrate, high-fat diet. Eating a high-carbohydrate diet constantly is not advised. This conditions the body to use only carbohydrates for fuel and not the fatty acids derived from fats.

For continuous activities of three to four hours, make sure that glycogen stores in the muscles and liver are at a maximum. Consider taking carbohydrates during the event in the form of carbohydrate solutions. The current recommendation is a 6 to 8 percent glucose solution.

You can make an excellent home-brewed 7.6 percent sports drink with reasonable sodium amounts. Add 6 tablespoons sugar and

1/3 teaspoon salt to each quart of water. Dissolve sugar and cool. The salt translates into a sodium concentration of 650 mg/liter. This small amount is good for marathon runners.

Electrolyte beverages can be used if the athlete tolerates them, but other electrolytes are not essential until after the event. Experiment during training to find the best beverage for you.

Eating sugar or honey just before an event does not provide any extra energy for the event. It takes about 30 minutes for the sugar to enter the bloodstream. This practice may also lead to dehydration. Water is needed to absorb the sugar into the cells. Furthermore, sugar eaten before an event may hinder performance because it triggers a surge of insulin. The insulin causes a sharp drop in blood sugar level in about 30 minutes. Competing when the blood sugar level is low leads to fatigue, nausea and dehydration.

A diet where 70 percent of calories comes from carbohydrates for three days prior to the event is sometimes helpful for endurance athletes. (See Table 1 for a sample menu.) Water retention is often associated with carbohydrate loading. This may cause stiffness in the muscles and sluggishness early in the event. A three-day regimen minimizes this effect. The previously suggested seven days of deprivation/repletion is not recommended due to increased risks of coronary heart disease. In addition, electrocardiograph abnormalities may occur and training during the deprivation phase may be difficult.

Water

Water is an important nutrient for the athlete. Athletes should start any event hydrated and replace as much lost fluid as possible by drinking chilled liquids at frequent intervals during the event. Chilled fluids are absorbed faster and help lower body temperature. (See Table 2.)

Fats

Fat also provides body fuel. For moderate exercise, about half of the total energy expenditure is derived from free fatty acid metabolism. If the event lasts more than an hour, the body may use mostly fats for energy. Using fat as fuel depends on the event's duration and the athlete's condition. Trained athletes use fat for energy more quickly than untrained athletes. Consumption of fat should

Table 1: Sample menu of a high-carbohydrate diet.

Food Item	Calories	Grams Carbohydrate
Breakfast		
8 ounces orange juice	120	28
1 cup oatmeal	132	23
1 medium banana	101	26
8 ounces low-fat milk	102	12
1 slice whole wheat toast	60	12
1 tablespoon jelly	57	15
Lunch		
2 ounces sliced ham	104	0
1 ounce Swiss cheese	105	1
2 slices whole wheat bread	120	25
1 leaf lettuce	1	0
1 slice tomato	3	1
8 ounces apple juice	116	30
8 ounces skim milk	85	12
2 cookies	96	14
Dinner		
3 cups spaghetti	466	97
1 cup tomato sauce	89	19
with mushrooms	5	1
2 tablespoons Parmesan cheese	45	0
4 slices French bread	406	78
1 slice angel food cake	161	36
1/4 cup sliced strawberries	13	3
1/2 cup ice cream	133	16
Snack		
16 ounces grape juice	330	83
6 fig cookies	386	81
TOTAL	**3,236**	**613** (75% of total calories)

Table 2: Recommendations for hydration.

Day before	Drink fluids frequently.
Pre-event meal	2-3 cups water
2 hours before	2-2 1/2 cups water
1/2 hour before	2 cups water
Every 10-15 minutes during the event	1/2 cup cool (45-55 degrees) water
After event	2 cups fluid for each pound lost
Next day	Drink fluids frequently. (It may take 36 hours to rehydrate completely.)

A varied diet will provide more than enough protein as caloric intake increases.

not fall below 15 percent of total energy intake because it may limit performance. Athletes who are under pressure to achieve or maintain a low body weight are susceptible to using fat restriction and should be told this will hinder their performance.

Fat may contribute as much as 75 percent of the energy demand during prolonged aerobic work in the endurance-trained athlete. There is evidence that the rate of fat metabolism may be accelerated by ingesting caffeine prior to and during endurance performance. However, insomnia, restlessness and ringing of the ears can occur with caffeine consumption. Furthermore, caffeine acts as a diuretic and athletes want to avoid the need to urinate during competition.

Protein

After carbohydrates and fats, protein provides energy for the body. Exercise may increase an athlete's need for protein, depending on the type and frequency of exercise. Extra protein consumed is stored as fat. In the fully grown athlete, it is training that builds muscle, not protein per se. The ADA reports that a protein intake of 10 to 12 percent of total calories is sufficient. Most authorities recommend that endurance athletes eat between 1.2-1.4 grams protein per kilogram of body weight per day; resistance and strength-trained athletes may need as much as 1.6-1.7 grams protein per kilogram of body weight. (A kilogram equals 2.2 pounds.)

Japanese researchers demonstrated that "sports anemia" may appear in the early stages of training with intakes of less than 1 gram/kilogram of body weight per day of high-quality protein. To calculate your protein needs, divide your ideal weight by 2.2 pounds to obtain your weight in kilograms. Then multiply kilograms by the grams of protein recommended.

A varied diet will provide more than enough protein as caloric intake increases. Furthermore, Americans tend to eat more than the recommended amounts of protein. Excess protein can deprive the athlete of more efficient fuel and can lead to dehydration. High-protein diets increase the water requirement necessary to eliminate the nitrogen through the urine. Also, an increase in metabolic rate can occur and, therefore, increase oxygen consumption. Protein supplements are unnecessary and are not recommended.

Vitamins and Minerals

Increased caloric intake through a varied diet ensures a sufficient amount of vitamins and minerals for the athlete. There is no evidence that taking more vitamins than is obtained by eating a variety of foods will improve performance. Thiamin, riboflavin and niacin (B vitamins) are needed to produce energy from the fuel sources in the diet. However, plenty of these vitamins will be obtained from eating a variety of foods. Carbohydrate and protein foods are excellent sources of these vitamins. Furthermore, the B vitamins are water soluble and are not stored in the body, so toxicity if not an issue. Some female athletes may lack riboflavin, so ensuring adequate consumption of riboflavin-rich food, like milk, is important. Milk products not only increase the riboflavin level but also provide protein and calcium. The body stores excess fat-soluble vitamins A, D, E and K. Excessive amounts of fat-soluble vitamins may have toxic effects.

Minerals play an important role in performance. Heavy exercise affects the body's supply of sodium, potassium, iron and calcium. Sweating during exercise increases the concentration of salt in the body. Consuming salt tablets after competition and workouts is not advised as this will remove water from your cells, causing weak muscles. Good sodium guidelines are to: 1) avoid excessive amounts of sodium in the diet and 2) consume beverages containing sodium after endurance events may be helpful.

Eating potassium-rich foods such as oranges, bananas and potatoes throughout training and after competition supplies necessary potassium.

Iron carries oxygen via blood to all cells in the body and is another important mineral for athletes. Female athletes and athletes between 13 and 19 years old may have inadequate supplies of iron due to menstruation and strenuous exercise. Female athletes who train heavily have a high incidence of amenorrhea (the absence of regular monthly periods) and thus conserve iron stores. Iron supplements may be prescribed by a physician if laboratory tests indicate an iron deficiency. Excess iron can cause constipation. To avoid this problem, eat fruits, vegetables, whole grain breads and cereals.

Calcium is an important nutrient for everyone as it is important in bone health and muscle function. Female athletes should have an adequate

supply of calcium to avoid calcium loss from bones. Calcium loss may lead to osteoporosis later in life. Choosing low-fat dairy products provides the best source of calcium.

The Pre-Game Meal

A pre-game meal three to four hours before the event allows for optimal digestion and energy supply. Most authorities recommend small pre-game meals that provide 500 to 1,000 calories.

The meal should be high in starch, which breaks down more easily than protein and fats. The starch should be in the form of complex carbohydrates (breads, cold cereal, pasta, fruits and vegetables). They are digested at a rate that provides consistent energy to the body and are emptied from the stomach in two to three hours.

High-sugar foods lead to a rapid rise in blood sugar, followed by a decline in blood sugar and less energy. In addition, concentrated sweets can draw fluid into the gastrointestinal tract and contribute to dehydration, cramping, nausea and diarrhea. Don't consume any carbohydrates 1 1/2 to 2 hours before an event. This may lead to premature exhaustion of glycogen stores in endurance events.

Avoid a meal high in fats. Fat takes longer to digest as does fiber- and lactose-containing meals.

Take in adequate fluids during this pre-game time. Avoid caffeine (cola, coffee, tea) as it may lead to dehydration by increasing urine production.

Don't ignore the psychological aspect of eating foods you enjoy and tolerate well before an event. However, choose wisely – bake meat instead of frying it, for example.

Some athletes may prefer a liquid pre-game meal, especially if the event begins within two or three hours. A liquid meal will move out of the stomach by the time a meet or match begins. Remember to include water with this meal.

The Post-Game Meal

Regardless of age, gender or sport, the post-game competition meal recommendations are the same. (See Table 3.) Following a training session or competition, a small meal eaten within 30 minutes is very beneficial. The meal should be mixed, meaning it contains carbohydrate, protein, and fat. Protein synthesis is greatest during the window of time immediately following a workout, and carbohydrates will help replete diminished glycogen stores. However, consuming food within the 30 minute window may be difficult for athletes – they often experience nausea or lack of hunger. Options to address this difficulty include:

- Carbs you can drink that contain protein. There are several liquid smoothies and beverages on the market that provide high protein and carbohydrates for replenishment. One classic is chocolate milk.
- If that is difficult, fruit, popsicles, oranges, bananas, bagels, melon or apple slices all would be better than not consuming any food.
- Many athletes turn to protein/amino acid supplementation in the form of powders or pills post-workout. These are unnecessary and have been linked to dehydration, hypercalciuria, weight gain and stress on the kidney and liver. Furthermore, athletes consuming supplements in place of meals should consult with their doctor or a registered dietitian before continuing.

Table 3. Two Pre-Event Meal Plans

Pre-Event Meal Plan I (approximately 500 calories)	
Milk, skim	1 cup
Lean meat or protein equivalent	2 ounces
Fruit	1 serving (1/2 cup)
Bread or substitute	2 servings
Fat spread	1 teaspoon

Pre-Event Meal Plan II (approximately 900 calories)	
Milk, skim	2 cups
Lean meat or protein equivalent	2 ounces
Fruit	1 serving (1/2 cup)
Pasta or baked potato	1 cup or 1 medium
Bread or substitute	2 servings
Vegetable	1 serving (1/2 cup)
Fat spread	1 teaspoon
Dessert: Angel food cake or plain cookies	1 piece 2 cookies

Maintain nutritional conditioning not only for athletic events but all the time. (See Dietary Guidelines for Americans <http://www.cnpp.usda.gov/DGAs2010-PolicyDocument.htm>.) A pre-game meal or special diet for several days prior to competition cannot make up for an inadequate daily food intake in previous months or years.

Lifelong good nutrition habits must be emphasized. Combine good eating practices with a good training and conditioning program plus good genes, and a winning athlete can result!

Other Resources

- *Winning Sports Nutrition*, video and training manual, University of Arizona, 1995.
- *Sports Nutrition Guidebook*, by Nancy Clark, Leisure Press, 1990.
- For recipes, see *Athlete's Kitchen* by Nancy Clark, published by Bantam Books, 1983.
- *Nutrition for Athletes: A Handbook for Coaches* produced by the American Alliance for Health, Physical Education and Recreation, 1201 Sixteenth Street, NW, Washington, DC 20036 or visit their website at *www.aahperd.org*.
- Order a copy of *You: A Guide to Food, Exercise and Nutrition* from Colorado Dairy Council, Inc., 12450 North Washington Ave., P.O. Box 33120, Thornton, CO, 80233-0120; telephone (303) 451-7711; cost $1.
- *Sports Nutrition Guidebook* by Nancy Clark, Leisure Press, 1996.
- Order a copy of *Eating for Peak Performance or Competition Nutrition* from Colorado Dairy Council, Inc., 12450 North Washington Ave., Thornton, CO, 80241; (800) 274-6455.
- Visit the American Dietetic Association's website at *www.eatright.org* for reliable nutrition information or to find a registered dietician.
- Visit the American College of Sports Medicine's website at *www.acsm.org* for a variety of information and brochures.
- "Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance." *Journal of the American Dietetic Association*. 2000;100:1543-1556.

References

Advances in Sports Medicine and Fitness, Volume 2, 1989.

Nutrition for Fitness and Sports, Melvin Williams, Brown, Benchmark, 1995.

Nutrition for the Recreational Athlete, Catherine Jackson, editor, CRC Press, 1995.

Krause's Food and Nutrition Therapy, 12th edition, L. Kathleen Mayhan and Sylvia Escott Stump, W.B. Saunders Company, 2008.

Acknowledgment is given to J. Anderson, foods and nutrition specialist and professor; L. Young, M.S., former graduate student, food science and human nutrition; S. Prior, former graduate intern, food science and human nutrition and K. Topham, graduate student, food science and human nutrition, Colorado State University, for the original manuscript and revision.

Prepared by Laura J. Connerly, Ph.D., Instructor - Family Resource Management, University of Arkansas Division of Agriculture, lconnerly@uaex.edu.