



## Feeding the Wildland Firefighter

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**R**ecent research has identified nutritional strategies that will improve the health, safety, and productivity of wildland firefighters. The right food sources, properly timed, provide energy and nutrients that help sustain work output and maintain the function of the immune system. Supplemental high-energy foods delay fatigue and enhance immune function while maintaining the firefighter's ability to think and make decisions during periods of hard work. This Tech Tip outlines simple strategies for maintaining health, safety, and performance during prolonged periods of arduous work.

### Energy

Research by the University of Montana Human Performance Laboratory and the Missoula Technology and Development Center (MTDC) has demonstrated the energy demands and energy intake of wildland firefighters. In a recent field study (Ruby and others 2002), male firefighters burned an average of 4,758 kilocalories a day while they consumed only 4,068 kilocalories. The daily caloric deficit of 690 kilocalories results in a 1.25-kilogram (2.76-pound) weight loss over the course of a 14-day assignment. Female



firefighters burned an average of 3,550 kilocalories per day, while consuming 3,222 kilocalories, for a daily deficit of 328 kilocalories. They lost 0.6 kilograms (1.3 pounds) of body weight in 14 days. This energy deficit could result in significant weight loss, including loss of lean body weight. When energy intake falls short of requirements, the body derives needed energy from muscle tissue. This loss of lean tissue will increase the likelihood of fatigue and could reduce the ability of a firefighter to perform arduous work.

The study by Ruby and others shows that some male firefighters may require over 6,000 kilocalories of food daily, while some females may require more than 5,000 kilocalories during a long, hard shift. The meals provided in fire camp are planned to meet the caloric demands of wildland firefighting. Computerized nutritional analysis of the meals yields a daily total of 5,800 kilocalories, but the firefighter must eat all the food provided to receive all 5,800 kilocalories. The computer analysis also indicates that most meals exceed dietary recommendations for fat and were somewhat low in nutritional carbohydrates. Complex carbohydrates (such as potatoes, corn, rice, beans, and whole-grained breads and pasta) provide energy while also supplying needed nutrients and fiber.



## Dietary Recommendations

Studies of endurance athletes, soldiers, and wildland firefighters support the need for a diet that is high in carbohydrates and low in fat. Carbohydrates help maintain immune function, while too much fat may degrade the function of the immune system, increasing the risk of upper respiratory and other health problems. We recommend the performance diet for wildland firefighters and for everyone who wants to engage in vigorous physical activity (table 1).

Table 1—The performance diet.

Nutrient	Percent of daily calories
Carbohydrates	60
Fat	25
Protein	15

You can approach these levels by:

- Increasing your intake of complex carbohydrates (potatoes, corn, rice, beans, and whole-grained breads and pasta) and fruit (fresh, dried, or canned)
- Maintaining your usual level of fat, emphasizing healthy fats in nuts, seeds, and oils while minimizing saturated and hydrogenated fats
- Consuming high-carbohydrate energy supplements during and immediately after work

### Protein

Endurance and strength athletes need 1.2 to 1.6 grams of protein per kilogram of body weight daily. Fire camp meals provide this much protein. Excess protein is not recommended for firefighters because it can compromise carbohydrate intake, increase fat intake, and lead to chronic dehydration in active individuals.

**Nutrients**—You can get the vitamins, minerals, antioxidants, and immune-friendly foods your body needs by eating the recommended number of servings of fruits and vegetables. For the prolonged arduous work of firefighting, you should try to eat four servings of fruit and five servings of vegetables daily (one serving is about the size of your fist). An apple or

orange is one serving, as is 1/2 cup of apricots, dried fruit, or fruit juice. Two and one-half cups of vegetables will meet the daily requirement. Select dark leaf lettuce and a variety of vegetables (such as green beans or carrots).



## Energy Supplements

Solid and liquid carbohydrate supplements provide muscle energy and help keep you thinking clearly while helping to maintain or even improve immune function.

### Solid Supplements

**During Work**—The energy bars used by endurance athletes are an excellent way to supplement energy between meals. Consuming one 250-kilocalorie bar between breakfast and lunch and one between lunch and dinner provides an additional 500 kilocalories of energy each day. Less expensive candy bars are a reasonable substitute for energy bars and have proven more palatable in taste tests. However, candy bars contain more fat than energy bars, and the chocolate in some bars tends to melt when exposed to heat.

**After Work**—Studies show that carbohydrate replacement (in liver and muscle) is most rapid during the 2 hours immediately after the end of the work shift. Firefighters should be provided at least 500 kilocalories of energy replacement in the 2 hours after work. Carbohydrate supplements will ensure the firefighter's ability to recover and be ready for work the following day. Liquid carbohydrate sources are absorbed faster than solid supplements; they aid

rehydration and may speed recovery. Grape and cranberry juice are high in carbohydrates. Ingesting some protein (1 gram of protein per 4 grams of carbohydrates) within 2 hours after work may reduce muscle stress and accelerate replacement of muscle glycogen. Sports recovery drinks that provide this ratio of carbohydrates and protein are available in powdered form.

***Combining the energy supplements consumed between meals with those taken after work yields an additional 1,000 kilocalories of energy.***

## Liquid Supplements

Firefighters need to consume fluids before, during, and after work to maintain hydration. Carbohydrate/electrolyte beverages (C/E or sports beverages) provide fluid, energy, and electrolytes needed during prolonged work. The sports beverage promotes increased fluid intake and helps maintain blood sugar during arduous work. The electrolytes help conserve fluid that might otherwise be lost in urine.



**During Work**—MTDC recommends that one-third to one-half of fluid needs be met by drinking a sports beverage. Because firefighters need about 1 liter (about 1 quart) of fluid for each hour of work, they will need 4 to 6 quarts of sports beverage for a 12-hour shift. Firefighters can be given packets of dried drink mix that they can mix as needed. A 3- to 5-percent carbohydrate solution (30 to 50 grams of carbohydrates per liter of water) is well tolerated during work in the heat. Four liters of water with 200 grams of carbohydrates provides 800 kilocalories of energy. The balance of fluid needs should be met by consuming water at regular intervals (about 8 ounces every 15 minutes). Drinking a sports beverage and water is the safest way to maintain hydration while providing additional carbohydrates to maintain blood glucose.



**After work**—To rehydrate and to replace muscle and liver carbohydrate stores, firefighters should consume about 2 quarts of a sports beverage in the 2 hours immediately after work. A higher carbohydrate concentration (10 to 15 percent) is tolerated after work, when the crew is traveling or waiting for transport. The electrolytes in the drink help retain the needed fluid. This approach ensures fluid replacement, muscle recovery, and optimal replacement of muscle carbohydrate stores (muscle glycogen).

*The liquid energy consumed during and after work provides an additional 1,000 kilocalories of energy.*

## Energy Summary

The energy consumed in meals, combined with solid and liquid carbohydrate supplements, provides the fuel to power firefighters during long shifts and extended assignments (table 2).

Table 2—Daily energy sources.

Energy source	Approximate kilocalories
Meals	4,000
Solid supplements	1,000
Liquid supplements	1,000
Total energy	more than 6,000

## Recommendations for Firefighter Nutrition

- Eat more complex carbohydrates (potatoes, corn, rice, beans and whole-grained breads and pasta).
- Eat fatty foods (steak, cheese) and added fats (margarine, mayonnaise) in moderation.
- Consume supplemental carbohydrate energy (energy or candy bars) between meals.
- Consume one-third to one-half of daily fluids in the form of a carbohydrate/electrolyte sports beverage. Carry enough powdered drink mix for 4 to 6 quarts of beverage.
- Consume solid and liquid energy supplements immediately after the end of the work shift.
- Eat four servings of fruits and five servings of vegetables daily (a serving is a fist-sized portion).
- Consider taking a daily vitamin/mineral supplement if dietary recommendations cannot be met, when environmental conditions (such as smoke) are severe, or when appetite or food availability limits energy and nutrient intake.



## Questions and Answers

### **Q. Has one sports beverage been proven to be more effective than the others?**

A. No. Research has not demonstrated meaningful differences among competing products. The important thing is to get fluid, carbohydrates (50 grams per liter), and electrolytes in your sports beverage.

### **Q. What about the so-called “energy” drinks? Are they suitable for hydration?**

A. No. Most of the beverages sold as energy drinks contain more carbohydrates (80 to 120 grams per liter) than are needed during work (30 to 50 grams per liter). The high concentration of carbohydrates could slow the rate at which fluid is absorbed from the intestines. In addition, most of these products contain caffeine (a diuretic), guarana, ephedra, or other stimulants that could interfere with the body's ability to withstand heat stress.

### **Q. Has one energy bar been proven to provide superior results?**

A. No. Studies have not demonstrated differences in athletic performance or immune function, regardless of the type of carbohydrates, or the balance of carbohydrates, protein, and fat in the product.

### **Q. Can candy bars be used to provide solid energy supplementation?**

A. Yes, but keep several points in mind. Candy bars contain more fat than energy bars. The chocolate in candy bars melts in the heat. Some candy bars contain peanuts that could trigger allergic reactions in a small number of firefighters. MTDC recommends a mix of candy and energy bars. Consume the chocolate before temperatures rise.

### **Q. Does a firefighter need additional protein?**

A. No. The protein provided in the meals is more than adequate, even for the arduous work of firefighting. Recent studies suggest that ingesting some protein (1 gram of protein per 4 grams of carbohydrates) within 2 hours after work may reduce muscle stress and accelerate replacement of muscle glycogen.

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## About the Author...

**Brian Sharkey** completed a Ph.D. in exercise physiology at the University of Maryland before coming west to join the faculty of the University of Montana and beginning a long association with MTDC. His work for the Forest Service has included research and development on fitness tests and programs, heat stress, hydration, nutrition, protective clothing, tools, work/rest cycles, employee health (wellness), and more. A researcher, author of several books, and past president of the American College of Sports Medicine, Dr. Sharkey's work has recently been honored with a USDA Distinguished Service Award, and a Forest Service Technology Transfer Award.

**Brent Ruby** completed a Ph.D. in exercise physiology at the University of New Mexico. He directs the University of Montana Human Performance Laboratory where he has conducted extensive studies on wildland firefighters. His work on energy expenditure was supported by a contract from the U.S. Department of Defense. His current studies focus on fatigue and immune function in wildland firefighters.

**Carla Cox** is a registered dietician with experience in clinical practice and teaching. She is completing requirements for a Ph.D. at the University of Montana. Her research focuses on the energy demands of prolonged arduous work.

All three authors practice what they preach, engaging regularly in vigorous endurance activities.

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## Library Card

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Describes research on nutritional strategies to improve the health, safety, and productivity of wildland firefighters. Some male firefighters might require over 6,000 kilocalories of food daily, while some females may require more than 5,000 kilocalories. Computerized nutritional analysis of the meals provided in fire camp shows that a firefighter would receive 5,800 calories daily, assuming that the firefighter ate all of the food provided. The analysis also indicated that most meals exceed dietary recommendations for fat and were somewhat low in nutritional carbohydrates. Solid and liquid energy supplements can help firefighters get the nutrition they need. The Missoula Technology and Development Center recommends that firefighters consume one 250-kilocalorie energy bar between breakfast and lunch, another 250-kilocalorie energy bar between lunch and supper, and another 500 kilocalories of energy during the 2 hours after work. In addition, MTDC recommends that one-third to one-half of a firefighter's fluid needs during work (1 liter per hour) be met by drinking a sports beverage. Firefighters should also drink 2 quarts of a sports beverage or juice in the 2 hours immediately after work.

Keywords: beverages, electrolytes, energy bars, energy cost of activities, food products, nutrients, nutrition, nutrition research, sports beverages

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