



# BEETROOT JUICE SUPPLEMENTATION AND EXERCISE

DEBRA WEIN, MS, RD, LDN, NSCA-CPT,\*D, AND KELLY MURPHY, RD, LDN

**W**e all remember the dreaded words at dinnertime “finish your beets.” Nowadays, research on the benefits of beetroot juice has athletes clamoring for the same deep red vegetable that had us wishing we had a dog under the table as children. This article will address possible benefits, proposed mechanisms, dosage, and frequency of this potential ergogenic aid.

Beets, a rich source of antioxidants and nitrates, may serve to improve blood pressure and blood flow throughout the body, including the muscles, brain, and heart (1). Humans regularly consume nitrates from sources such as beets, lettuce, celery, and spinach (see Table 1 for additional sources). In the body, these nitrates are absorbed in small amounts in the mouth but primarily in the stomach, where they are quickly converted to nitric oxide (NO) (1).

## THE ROLE OF NITRIC OXIDE

Increasing NO can be beneficial for individuals due to its role in regulating blood flow, neurotransmission, immune function, blood sugar regulation, calcium regulation, and muscle contraction (7). Potentially, there could be additional benefits for athletes as it may help to increase oxygen in contracting muscles, decrease adenosine triphosphate (ATP) cost during exercise, increase tolerance to long-term high-intensity exercise, and time to exhaustion (1,2).

When engaging in moderate-intensity exercise, the lungs take in oxygen at a rate that is very similar to the uptake of oxygen into skeletal muscles (1). Oxygen intake into both lungs and muscles increases exponentially with exercise (1). When exercise intensity increases to a certain level, the uptake of oxygen into the lungs causes a shift in the energy system utilized, and therefore creates an increased oxygen cost on the muscles (1). In other words, when an individual cannot breathe in as much oxygen during exercise, the muscles have to work through a different energy system to continue performing the same function.

Several studies have shown increased exercise performance or a decreased time to exhaustion when participants were given beetroot juice supplements prior to exercise (1,2,4,6,7). In one study, researchers tested active males on three different

occasions and found that there was no increase in oxygen intake by the lungs in those individuals consuming the beetroot juice. However, the researchers did find that the amount of hemoglobin (which carries oxygen in the blood) in the muscle was higher during exercise in those who consumed the beetroot juice. In addition, the beetroot juice group had increased oxygen delivered to the muscle, which allowed for increased exercise until exhaustion (6).

## TIMING AND DOSAGE

Recently, researchers looked into the timing, concentrations, and frequency of consumption of the juice needed to promote performance improvements.

Some studies have looked at the best amount of beetroot juice to consume. One study compared 4 mmol, 8 mmol, and 16 mmol nitrate concentrated beetroot juice to determine if a greater benefit existed from consuming a more concentrated amount. Athletes were tested on four separate occasions during a three-week period. Each participant consumed the beetroot juice 2.5 hr before performing a moderate- or high-intensity exercise (which lasted approximately five minutes) and found that all concentrations increased nitrite concentration and oxygen delivery in the blood (7). Additionally, the participants who consumed 8 mmol and 16 mmol concentrations improved time to failure of exercise. The 16 mmol concentrated beetroot juice group improved time to exhaustion by 12%, whereas the 8 mmol concentration group improved results by 14%. The results show that individuals who consumed 8 mmol concentrations actually improved the most in time to failure of exercise (7).

In other studies, researchers compared consumption between 2 – 3 hr prior to exercise and found the beetroot juice had beneficial effects on exercise 2 – 2.5 hr after drinking it (1,2,4,5,7). One such study provided 20 trained athletes with 140 mL of beetroot juice of 8.7 mmol concentration, 2.5 hr before performing a one-hour cycling time trial. Although the results found higher blood nitrate levels, there was no improvement in time-trial performance or power output in the beetroot juice supplemented athletes versus those given a placebo. Researchers determined that a single dosage of beetroot juice had no immediate benefits on exercise (5).

Similarly, another study had athletes ingest 500 mL of 8 mmol concentrated beetroot juice for six days and then performed exercise tests on days four, five, and six. Results showed an increase in time to exhaustion and an increase in oxygen uptake on all days tested (1). An alternate study provided athletes with the beetroot juice supplement only on the days of testing (on four separate occasions) and found significant benefits as well (7). Although the results of the previous study were beneficial for single-dose supplementation, it should be noted that the athletes were supplemented more than one time and continued to show beneficial effects after the study. As a result, continuous supplementation as opposed to one-time dosage of beetroot juice is supported.

### ARE THERE OTHER FOODS BESIDES BEETROOT?

Beetroot is not the only food that contains inorganic nitrates, which may provide these potential benefits. Dark green, leafy vegetables like spinach also contain a fair amount of nitrates; however, most research has focused on beetroot juice. In order to get the 8 mmol of nitrates (the optimal amount shown to have a beneficial effect), an individual would need to consume 200 – 300 g of spinach, or approximately 10 cups (4). This amount is a lot of spinach to eat before a workout and may be an impractical way to obtain nitrates.

The question may arise that if it is the nitrates in the beetroot juice that provide these benefits, then why not just consume nitrates directly instead of the juice? A lot of speculation has surrounded the consumption of nitrates since previous studies have linked them to cancer. As a result, it has led to strict regulation of nitrate concentrations in food and water. Current research is beginning to show the benefits of some nitrate-rich foods, which is leading to further investigation within this area (4). Researchers may also argue that beetroot juice does not just contain nitrates; it also contains substances like betaine and antioxidants, which are being tested to determine if any beneficial effects on exercise exist in addition to the nitrates. Therefore, it cannot be concretely stated that it is the nitrates alone in the beetroot juice that attribute to all of these benefits (2). However, benefits were seen within the cited studies.

### BOTTOM LINE

Consuming beetroot juice prior to high-intensity exercise may help improve a workout by increasing the amount of time before lactic acid builds up. Currently, there are multiple products that are sold in health food stores that are concentrated to 8 mmol nitrate in 70 mL (or 2.3 oz) bottles, which may be consumed prior to exercise.

## REFERENCES

1. Bailey, SJ, Winyard, P, Vanhatalo, A, Blackwell, JR, Wilkerson, DP, Tarr, J, Benjamin, N, and Jones, AM. Dietary nitrate supplementation reduces the O<sub>2</sub> cost of low-intensity exercise and enhances tolerance to high-intensity exercise in humans. *Journal of Applied Physiology* 107: 1144-1155, 2009.
2. Breese, BC, McNarry, MA, Marwood, S, Blackwell, JR, Bailey, SJ, and Jones, AM. Beetroot juice supplementation speeds O<sub>2</sub> uptake kinetics and improves exercise tolerance during severe-intensity exercise initiated from an elevated metabolic rate. *American Journal of Physiology Regulatory Integrative and Comparative Physiology* 305: 1441-1450, 2013.
3. Bryan, NS and Hord, NG. Dietary nitrates and nitrites. In: Bryan, N (Ed.), *Food Nutrition and the Nitric Oxide Pathway*. Lancaster, PA: Destech Pub Inc; 59-77, 2010.
4. Cermak, NM, Gibala, MJ, and van Loon, LJ. Nitrate supplementation's improvement of 10-km time-trial performance in trained cyclists. *International Journal of Sport Nutrition and Exercise Metabolism* 22: 64-71, 2012.
5. Cermak, NM, Res, P, Stinkens, R, Lundberg, JO, Gibala, MJ, van Loon, LJ. No improvement in endurance performance following a single dose of beetroot juice. *International Journal of Sport Nutrition and Exercise Metabolism* 22: 470-478, 2012.
6. Thompson, KG, Turner, L, Prichard, J, Dodd, F, Kennedy, DO, Haskell, C, Blackwell, JR, and Jones, AM. Influence of dietary nitrate supplementation on physiological and cognitive response to incremental cycle exercise. *Respiratory, Physiology, and Neurobiology* 13: 412-416, 2013.
7. Wylie, LJ, Kelly, J, Bailey, SJ, Blackwell, JR, Skiba, PF, Winyard, PG, Jeukendrup, AE, Vanhatalo, A, and Jones, AM. Beetroot juice and exercise: Pharmacodynamics and dose-response relationships. *Journal of Applied Physiology* 3: 325-336, 2013.

---

## ABOUT THE AUTHOR

*Debra Wein is a recognized expert on health and wellness and designed award-winning programs for both individuals and corporations around the United States. She is the President and Founder of Wellness Workdays, Inc., ([www.wellnessworkdays.com](http://www.wellnessworkdays.com)) a leading provider of worksite wellness programs. In addition, she is the President and Founder of the partner company, Sensible Nutrition, Inc. ([www.sensiblenutrition.com](http://www.sensiblenutrition.com)), a consulting firm of registered dietitians and personal trainers, established in 1994, that provides nutrition and wellness services to individuals. She has nearly 20 years of experience working in the health and wellness industry. Her sport nutrition handouts and free weekly email newsletters are available online at [www.sensiblenutrition.com](http://www.sensiblenutrition.com).*

*Kelly Murphy is a Registered and Licensed Dietitian working for the Dallas, TX office of Sensible Nutrition Inc., a nutrition consulting firm that provides one-on-one nutrition counseling. She has extensive experience with nutrition and wellness as well as athletics. Murphy obtained her undergraduate degree from Cornell University, where she was a four-year varsity athlete. She enjoys combining her passions for both athletics and nutrition to help individuals lead healthier lives.*

# BEETROOT JUICE SUPPLEMENTATION AND EXERCISE

TABLE 1. SELECTED FOOD SOURCES OF NITRATES (3)

NITRATE CONTENT	CONTENT (PER KG OF FRESH VEGETABLE)	COMMON VEGETABLES
Very high	2,500 mg/40 mmol	Beetroot and beetroot juice, celery, lettuce, and spinach
High	1,000 - 2,500 mg/18 - 40 mmol	Chinese cabbage, celeriac, endive, leek, parsley, and kohlrabi
Moderate	500 - 1,000 mg/9 - 18 mmol	Cabbage, dill, turnip, and carrot juice
Low	200 - 500 mg/3 - 9 mmol	Broccoli, carrot, cauliflower, cucumber, pumpkin, and vegetable juice
Very low	< 200 mg/< 3 mmol	Asparagus, artichoke, broad beans, green beans, peas, capsicum, tomato, watermelon, potato, sweet potato, garlic, onion, eggplant, and mushroom