Is Exercise the Best Antioxidant Supplement?

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As an unexpected consequence of the metabolic steps that convert food into energy, the body produces molecules commonly called free radicals. When not produced in too high of abundance, free radicals are harmless to the body's life process, and in fact are known to be helpful. However, when overproduced by the cell, free radicals can become dangerous cellular adversaries to numerous life-sustaining processes. To combat the potential harmful effects of free radicals, the cells in turn produce free radical scavengers, referred to as antioxidants. In essence, antioxidants help to neutralize the destructive characteristics of free radicals. Personal trainers and exercise professionals are regularly asked by their clients and students whether exercise contributes to or helps to buffer the effect of free radicals and whether they should supplement with antioxidants. This article will add insight into this complex mystery.

What is a Free Radical?

Free radicals, also referred to as reactive oxygen species or ROS, are molecules that contain one or more unpaired electrons in their outer orbit, rather than having matched pairs of electrons. Thus the molecule has an odd number of electrons. They are unstable molecules in this unpaired electron state, and become highly reactive with other molecules in their quest to attain molecular stability. During the sequence of chemical reactions that manufacture energy for our cells, called mitochondrial respiration, ROS are naturally produced as byproducts of this essential metabolic process. There are several different types of ROS (e.g., hydroxyl radical, the superoxide radical, the nitric oxide radical and the lipid peroxyl radical), which also come from cigarette smoke, environmental pollutants, radiation, ultraviolet light, certain drugs, pesticides, and industrial solvents (Bagchi and Puri, 1998). In its quest to

become more stable, the free radical will attach itself to other molecular structures, robbing the molecule of an electron(s). This attachment spontaneously generates another free radical, starting a chain reaction which can lead to damage to cell membranes, DNA and protein breakdown (Clarkson and Thompson, 2000). It should be noted that not all ROS are harmful. Some free radicals help to wipe out invading pathogenic (disease causing) microbes, as part of the body's defense mechanism (Bagchi and Puri, 1998).

What are Antioxidants?

Antioxidants defend against the harmful effect of free radicals, which are associated with heart disease, cancer, arthritis, aging and many other diseases (Bonnefoy, Drai, and Kostka, 2002). Antioxidants are very stable molecules capable of neutralizing free radicals by donating an electron to them. Some antioxidants are produced during metabolism (e.g., glutathione, ubiquinol, and uric acid), while many others are obtained from foods in the diet. In children, it appears that the body's arsenal of antioxidants is a most satisfactory defense process. However, this stockpile of defense mechanisms appears to weaken considerably with aging.

The best-known antioxidants are vitamin E, vitamin C and carotenoids. Vitamin E is an important fat-soluable antioxidant in cell membranes. Vitamin C is a water-soluble antioxidant and beta-carotene, the major carotenoid precursor of vitamin A, is also a very specialized antioxidant. Essentially the body attempts to maintain a balance between the production of free radicals and the antioxidants that combat them. Too many ROS produced leads to a condition referred to as 'oxidative stress,' which is a precursor to cell, tissue and organ damage.

Exercise and Antioxidants: A Mystery is Unraveling

During cardiovascular exercise, oxygen consumption increases dramatically. This leads to a corresponding increase in free radical production. So, does free radical production during regular exercise exceed the protective capacity of the body's antioxidant defense system? According to Gomez-Cabrera et al. (2005), it appears that ROS will only cause damage when the aerobic exercise is too exhaustive. More intriguing, new research suggests that exercise-induced free radical production actually promotes insulin sensitivity in humans (Ristow et al. 2009), and thus a catalyst in the prevention of type 2 diabetes.

Insulin, which is released from the pancreas, triggers muscle and liver tissues in the body to consume glucose from the blood, and store it for fuel (the liver and muscle tissues store glucose in the form of glycogen). This process lowers blood sugar to stable levels. Thus, in someone with improved insulin sensitivity (as a result from exercise), the liver and the muscles respond very effectively in absorbing the blood glucose, keeping blood glucose at preferred levels, potentially managing or preventing insulin resistance and type 2 diabetes. Ristow and colleagues (2009) state that antioxidant supplementation may actually block the many beneficial effects of exercise on improved insulin sensitivity. The authors continue that as an adaptive response to moderate intensity exercise, muscle antioxidant defense systems are up-regulated (a process in the regulation of gene expression, in which the number, or activity of gene receptors increases in order to increase sensitivity of a response). This stimulates specialized signaling message pathways to activate a number of enzymes and proteins that play important roles in maintenance of intracellular oxidant-antioxidant homeostasis (See Figure 1).

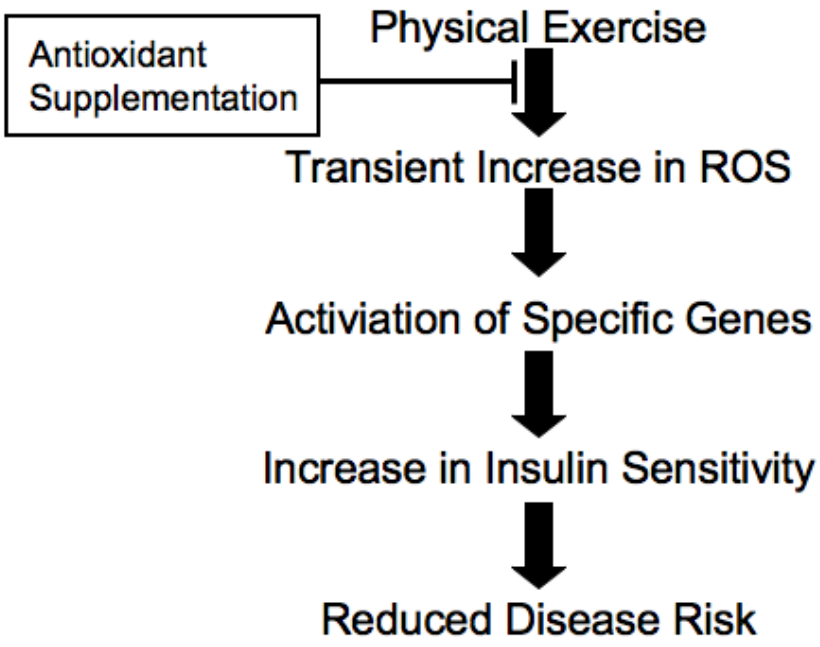

Figure 1. Physical Exercise and Antioxidant Health Promotion (adapted from Ristow et al. 2009).

Does Antioxidant Supplementation Improve Exercise Performance?

The supplement industry is booming with supplement manufacturers proclaiming that athletes can perform better, recover quicker, and exercise more rigorously with their antioxidant supplements. However, Clarkson and Thompson (2000) summarize that further long-term research is needed to assess the efficacy and safety of long-term antioxidant supplementation. The authors conclude that there is insufficient data suggesting that athletes and those who exercise regularly would benefit from supplementation. Indeed, Ristow and colleagues claim from their research that the additional supplemental doses of antioxidants some people are taking are more harmful than beneficial.

What is the Verdict? Is Exercise the Best Antioxidant Supplement?

While the controversy about the benefits and/or harmful effects of antioxidant supplementation continues, most recent research indicates the importance of regular,

moderate intensity cardiovascular exercise in conjunction with a eating a diet rich in foods high in antioxidants. Food choices such as fruits (cranberries, blueberries, and blackberries), vegetables (beans, artichokes and Russet potatoes) and nuts (pecans, walnuts and hazelnuts) and spices (ground cloves, ground cinnamon and oregano) are high in natural antioxidants. Make sure the exercise isn't too exhaustive, as it seems there is an intensity threshold for the body in building and developing its optimal antioxidant defenses. Encourage clients to be creative with their antioxidant food choices and be committed to their exercise programs…their long-term health may be counting on it.

References:

Bagchi, K. and Puri, S. (1998). Free radicals and antioxidants in health and disease. Eastern Mediterranean Health Journal, 4(2), 350-360.

Bonnefoy, M. Drai, J., and Kostka, T. (2002). Antioxidants to slow aging, facts and perspectives. Presse Medicine, 31(25), 1174-1184

Clarkson, P.M. and Thompson, H.S. (2000). Antioxidants: what role do they play in physical activity and health? American Journal of Clinical Nutrition, 72(suppl), 637S-646S.

Gomez-Cabrera, M-C, Borras, C., Pallardo, F.V., Sastre, J., Ji, L.L. and Vina, J. (2005). Decreasing xanthine oxidase-mediated oxidative stress prevents useful cellular adaptations to exercise in rats. The Journal of Physiology, 567(Pt 1), 113-120.

Ristow, M., Zarse, K., Oberbach, A., Kloting, N., Birringer, M., Kiehntopt, M. et al. (2009). Antioxidants prevent health-promoting effects of physical exercise in humans. PNAS, 106(21), 8665-8670.

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