Antioxidants for Exercising Horses

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Could feeding antioxidants to your horse help him through a performance problem? Antioxidants, whether found in the diet or supplemented, could potentially help exercising horses experiencing oxidative stress, said Catherine Dunnett, BSc, PhD, a nutritionist at Independent Equine Nutrition Ltd. in Newmarket, United Kingdom. Dunnett discussed the role of antioxidants and how they work to fight the dangerous effects of free radicals and reactive oxygen species (ROS) in her presentation "Antioxidants in Physiology and Nutrition of Exercising Horses" at the sixth equine school at the Alltech Symposium in Lexington, Ky.

Free radicals are chemicals that have an unpaired electron, which makes them very reactive," said Dunnett. "ROS might or might not have an unpaired electron, but are also reactive. This reactivity--caused by the desire to acquire another electron for stability--can result in damage to DNA, lipids, proteins, and carbohydrates in the horse's body. It has been suggested that these reactive oxygen species might contribute to muscle damage and fatigue, which can result in poor performance or exercise intolerance. Free radicals and ROS (pro-oxidants) are byproducts of normal metabolism, and the body does use these substances for it's own benefit. So, free radicals and ROS can be useful, but only when produced in controlled amounts and in the 'right place at the right time.'

"Under normal conditions, the deleterious effects of ROS are counteracted by the body's antioxidant defenses, which are contributed to through dietary intake of key nutrients," she continued. These key nutrients include vitamins C and E; trace minerals such as copper, manganese, zinc, iron, and selenium; and phytochemicals (certain plant chemicals, such as carotenoids, that researchers believe might impart health benefits such as better protection from cancer).

Dunnett explained that the balance between antioxidants and pro-oxidants is tipped slightly in the favor of oxidation (or the pro-oxidants). "However, when this balance is seriously tipped in favor of oxidation, oxidative stress has occurred," she explained. "Oxidative stress may arise due to an increased production of free radicals

or ROS, which can occur as a result of disease or infection, or as a consequence of exercise. Oxidative stress may be exacerbated when dietary antioxidant intake is reduced, or where intake of trace mineral co-factors is insufficient to facilitate antioxidant support."

Several studies have confirmed that exercise can lead to oxidative stress. Dunnett explained that the exercising horse requires more oxygen, sometimes up to 30 times the amount needed at rest to facilitate energy production. The resulting increased throughput through the energy generating pathway might indirectly lead to damage of the muscle fibers as a result of increased ROS production and subsequent disruption of muscle fiber membranes. The degree of oxidative stress is dependent on the intensity and duration of the exercise.

In addition, there are also a number of diseases where markers of oxidative stress have been identified in the horse. These include exercise-induced pulmonary hemorrhage, muscle myopathy, joint disease, and chronic obstructive pulmonary disease. Aging might also be a result of cumulative oxidative damage. Other contributors to oxidative stress include environmental factors such as allergens or pollution, ultraviolet or other forms of radiation, and injury.

Antioxidants play several roles in the fight against pro-oxidants and oxidative stress. Preventive antioxidants suppress the formation of free radicals, while free radical scavengers--such as alpha-tocopherol (vitamin E)--confer stability by giving up an electron, thus becoming oxidized themselves to form a more stable radical. Other antioxidant co-factors, such as the metals iron and copper, will find themselves bound to transport proteins in the blood so they do not contribute to radical formation. Some antioxidants are produced in the horse's body (such as vitamin C), while others are found in the diet.

Vitamin E

Vitamin E is one of the major dietary antioxidants and the term vitamin E actually refers to a group of compounds known as tocopherols. These can be found in vegetable oils, an excellent source for vitamin E, but the level and type of tocopherol depends on the type of vegetable oil. It has been demonstrated that horses might absorb natural sources of vitamin E better than synthetic forms. Interestingly, supplementing a horse's diet with vegetable oil might actually bring about an increased need for vitamin E.

"The increased fat oxidation that occurs during sub-maximal exercise following fat supplementation is likely to

increase the need for antioxidant support, particularly vitamin E due to the increased production of reactive oxygen species." Dunnett explained. "Although this increased requirement for vitamin E may be in part satisfied by the natural tocopherol content of the oil concerned, much of this is required to protect the oil itself from oxidation (rancidity). Vitamin E supplements are available as powders or liquids."

Dunnett said that human and animal studies suggest that for soya or corn oil, 120 mg of vitamin E per 100 grams of oil is necessary. This supplementation will help maintain the normal antioxidant balance.

Vitamin C

Otherwise known as ascorbic acid, vitamin C, is a weak acid, but a potent antioxidant that easily gives up electrons to provide stability to reactive species. Dunnett said the horse has no dietary requirements for vitamin C, since it is naturally produced in the liver from glucose. However, supplementation might be beneficial for sick horses or in times of stress. During times of sickness and stress, the body might not be able to produce adequate vitamin C to meet the increased requirement. She cited one study in which foals stressed by weaning had lower levels of vitamin C in their systems. Another study suggested that supplementation of vitamin C can improve antibody response after vaccination in older horses, especially those with Cushing's disease.

There are now commercial supplements of vitamin C, but it is important to remember that when in excess, ascorbic acid can promote the formation of free radicals.

Trace Minerals

Trace minerals such as copper manganese, zinc, iron, and selenium support the function of other antioxidants. These nutrients also can act as pro-oxidants by promoting the formation of free radicals. Therefore, these minerals are normally found in the body bound to proteins such as hemoglobin, transferrin, and ceruloplasmin.

Selenium is the most studied of the trace minerals. It is known that the selenium content of feeds is dependent on the selenium content of the soil on which grain is grown. If a horse is fed a product from a selenium deficient area, selenium supplementation might be necessary. The maximum tolerable level of selenium is reported to be 2 mg/kg of diet, according to the National Research Council (NRC). According to research since NRC recommendations came out in 1989, the toxic level can vary from 5-40 mg/kg of diet. Other research has supported supplementation of the yeast form (mainly in the form of selenomethionine) over sodium selenite due to greater digestibility.

Supplementation

Dunnett said that the effect of antioxidant supplementation has been studied in the horse, but results are as yet inconclusive. She cited one study in which antioxidant supplementation significantly increased plasma concentration of reduced ascorbic acid and alpha-tocopherol at rest and during exercise. The effect of the antioxidants on the degree of oxidative stress was not able to be measured since the exercise test failed to produce significant oxidative stress in the study horses. She said that it seems likely that the antioxidants would be able to suppress the development of significant oxidative stress during exercise.

"However, supplementation may become more important when intake from the diet is insufficient, or where the production of ROS is greater, for example, as the result of disease or where exercise intensity or duration is increased," she said.

Dunnett said at this time we have more questions than answers. For example, can we ease the effects of aging with antioxidants? Should we aim to provide an optimal supply of antioxidants or hypersupplement? Should antioxidants be provided individually or as "cocktails," mixtures of different antioxidants blended together? These are all areas that need study in the horse.
