Silicon and Equine Bone Health

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Prevention and treatment of skeletal injuries in performance horses is an on-going struggle for horse owners and trainers. Lameness tends to be one of the primary reasons why a horse's athletic performance either declines or never reaches its potential. Reducing the injury rate of horses is not only a major animal welfare issue; but also it represents a substantial economic concern. With these points in mind, it is understandable for horse owners and trainers to be continually searching for ways to keep their horses sound.

The implementation of proper training techniques is an important way to reduce injuries, which, of course, is much more complicated than one may think. Contrary to popular belief, for example, there are many advantages to training young horses that are still skeletally immature. While the young horse is growing, the skeletal tissue has the greatest capacity to strengthen. Though not commonly recognized as such, bone is a very dynamic tissue that constantly changes to accommodate forces placed upon it. When one increases the load upon bone, it becomes stronger particularly if it is given sufficient time to respond to the forces without being overloaded. In contrast, when load is reduced on bone, it responds by becoming weaker. These facts point out the inherent problems with stalling of young horses without giving them sufficient exercise.

The question arises as to the proper intensity and amount of training to give horses so that their bones are strengthened without being damaged. Through scientific studies, we are gradually finding answers to determine how much exercise is needed to optimize skeletal strength, but our understanding of these aspects of equine physiology will require ongoing research.

Since there are many questions remaining as to what are effective injury reducing training programs, owners and trainers have been adopting other ways to deal with the problems of equine lameness. The fields of equine physiology and nutrition are providing solutions through creation of scientifically formulated diets for the purposes of not only providing required sustenance but also for their prophylactic benefits generally through manipulated bone health. Bioavailable silicon, for example, is a scientifically discovered essential nutrient that studies indicate has promising benefits when added to the equine diet.

Silicon in the Environment Silicon is the second most common element of the Earth's crust that is found throughout the environment; it is, for instance, a major constituent of sand. Silicon dioxide (SiO_2) in the quartz crystals of sand cannot be absorbed by the horse (it is not bioavailable), which renders it useless as a nutritional aid. Plants, however, use silicon to provide rigidity and structure to some of their cell walls, from which horses are able to obtain small amounts in their normal diet of forage and grain. It should be noted, however, that processing of commercial horse feeds appears to reduce silicon's availability from these sources.

Despite its ubiquitous nature, surprisingly little is known about the nutritional importance of silicon in the diet of mammalian species. That being said, the American Institute of

Nutrition recently reformulated their published formulas of purified diets for experimental rodents, and made the decision to include silicon as a required nutrient. This change was brought about as a result of research demonstrating that it can interact with other nutrients for apparent beneficial effects.

Silicon in Bone and Connective Tissues

Most people think of bone as being made primarily from the minerals calcium and phosphorus. Much more, of course, goes into bone than just these two minerals. To begin with, bone is constantly undergoing changes as it removes old or damaged components and replaces them with new healthy elements. Silicon plays a role in the development of new bone, and it is involved with the calcification process. Interestingly, in the early stages of calcification, silicon and calcium content are low but both increase as mineralization progresses. As bone becomes fully mature, however, silicon content decreases while calcium remains high. Though its exact role has yet to be determined, silicon would appear to be exceptionally critical in the young, growing animal when the skeleton is undergoing rapid development. Support for the theory that silicon is involved in an early stage of bone formation is founded upon studies in which chicks had defective bone growth after being fed a silicon deficient diet. While being involved in the mineralization process of bone, silicon also appears to play a major role in the formation of the collagen matrix of bone and cartilage. This matrix is necessary to prevent these tissues from becoming brittle and susceptible to damage. When silicon is deficient in the diet, the formation of the matrix appears to be limited; potentially resulting in even greater problems than if it is deficient in the mineralization process. In tissue cultures of bone and cartilage, bone growth induced by silicon appears to be mainly due to an increase in collagen content. The formation of glycosaminoglycans, the major polymeric molecule of the bone matrix, has also been shown to require silicon. Again, when chicks were fed a silicon-deficient diet, collagen content in the frontal bones was reduced. Additionally, the amount of articular cartilage was reduced compared to chicks that were supplemented with silicon. At the molecular level, silicon has been shown to be involved with mucopolysaccharide synthesis in the formation of articular cartilage and connective tissue, and to be an integral component of the mucopolysaccaride-protein complex and collagen of connective tissues.

Supplemental Silicon in Horses

Though the National Research Council (1989) has not specified a specific requirement for silicon in horses, benefits have been demonstrated by feeding a bioavailable silicon source. As part of a large, blinded FDAcontrolled study, dramatic decreases in injury rates were reported in race-trained Quarter Horses fed a supplemental silicon source. The control group of horses not receiving supplemental silicon had more horses experience injuries and had to be removed from training than horses that were able to complete the study (Figure 1). All three treatment groups receiving the silicon source at a low, medium and high dosages had more horses complete the study without injury than were injured. Furthermore, horses supplemented with the medium and high doses of silicon were able to train and race nearly twice the distance (an average of 90,438 and 82,928 meters respectively) before experiencing an injury than did the control group (49,503 meters; Figure 2). Interestingly, the medium treatment group even had faster race times than did the control group at the middle race distance. It is unlikely that the addition of silicon made the horses faster. Rather, it is probably that the faster horses were better able to withstand the rigors of racing, remain on the study, and increase the average speed of the whole group. By contrast, it is likely the faster horses (the ones placing more load upon their skeleton) in the control group were injured and removed from the study leaving only the slower horses. More studies were needed to try and determine what was causing the decreased injury rates. At Michigan State University, recent studies demonstrated an increase in the concentration of a marker of bone formation in broodmares during the first 45 days after supplementation began when the mares foaled. There was also a decrease in the concentrations of a marker of bone resorption by day 45 in yearlings after the beginning of supplementation. At least in the mature animal, bone formation and resorption tend to be equal. Hence, the amount of bone present tends to remain relatively constant. If either bone formation increases or bone resorption decreases, researchers typically assume the result to be positive in regards to bone health.

Benefits of silicon to humans have also been shown. Increased femoral density in osteoporotic women receiving absorbable silicon for four months has been reported. The National Osteoporosis Society recently funded a large randomized, placebo-controlled clinical trial to determine if orthosilicic acid is a treatment for osteoporosis after a pilot study demonstrated silicon supplementation of osteoporotic postmenopausal women increased spinal bone mineral density by 3%. The exact mechanism for enhanced bone metabolism, however, still needs to be determined.

Summary

Will feeding with bio-available silicon eliminate all injuries from one's training program? Obviously the answer is no. Although the research that has been done thus far has clearly demonstrated a large decrease in the number of horses injured while being fed this substance, we will continue to research the role silicon plays in the health of bone and cartilage. At this time, we can conclude that though proper training and good nutrition are still needed, supplementing horses with bioavailable silicon appears to be a promising method to aid in the prevention of injuries to equine athletes.

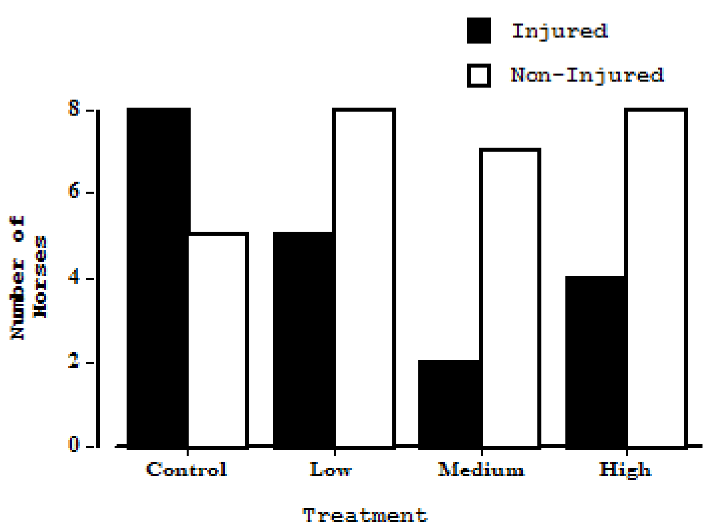

Figure 1. Comparison by treatment of racing-related injuries in horses fed with
bio-available silicon

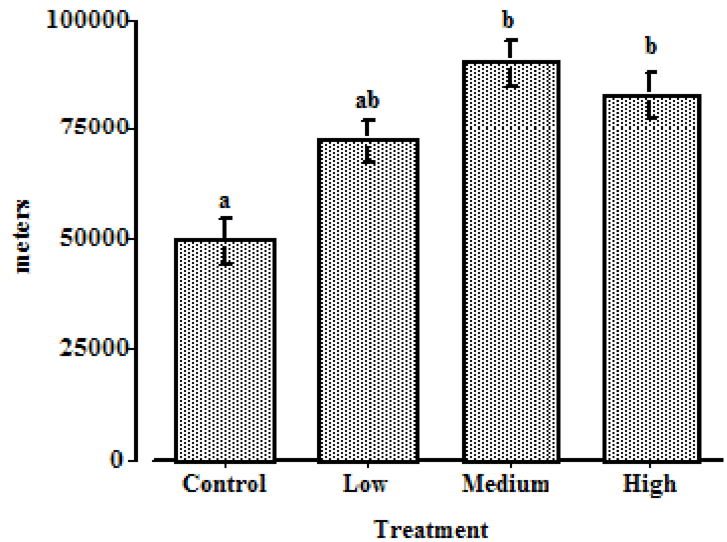

Figure 2. Distance in meters to first failure (or completion of project if no injury occurred of horses fed ab
Treatment means not sharing the same superscript differ (p<.05)

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