

Equine Therapeutic Nutrition I:

Nutritional Supplement Ingredients, The Good, The Bad and The Useless

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Introduction

Nutritional supplementation is the addition of selected nutrients in amounts higher than in the current diet. The body has mechanisms to control the absorption, storage and excretion of most nutrients, this results in a wide margin of safety. Even so, the amount of a particular nutrient supplemented should be based on age, weight, reproductive status, metabolic and disease situation of the individual and not a one size fits all recommendation. Proper nutritional supplementation can greatly enhance both therapeutic and preventive health regimens. Practitioners should participate heavily in the design of supplementation programs for all of their patients to whom nutrients are supplemented, however, too many products are being introduced to maintain current knowledge of them all. Products need to be evaluated on an ingredient by ingredient basis. The following paper will give guidelines on what questions to ask, how to gather answers, how to compare product to product, and will list some nutrients commonly supplemented with brief descriptions and grouped according to common uses. Herbal ingredients will not be discussed. Herbs are not nutrition, they contain chemicals that exert pharmacological activities.

Do they work?

A very common question that equine practitioners are asked about supplements is, does this product work? To answer that question, work must be defined. Relief of pain or other symptoms may be the desired end-point. If so, short term supplementation of many ingredients including herbs and hormone pre-cursors will work. Most of these types of ingredients should not be supplemented for long periods. As opposed to chemicals that enter the body and change how the metabolic processes work, supplementation of nutrients provide extra raw materials that are incorporated into the normal functioning of a system. Except in the case of a frank deficiency, improvements seen through nutritional supplementation are much slower than the changes caused by drug therapies. Many times the enzyme systems must "ramp up" before they can utilize the newly provided nutrients. Depending on the turnover rate of the tissues in question, structural changes through nutritional supplementation can take weeks, not days, to be seen. If the desired end-point is correction of an underlying problem, not just treatment of symptoms, then there are fewer products that actually work.

How to gather information

The first step in categorizing products or ingredients between the Good, the Bad and the Useless is to gather reliable information. As with any other product, marketing literature is a good source of potential uses, but it can't be taken at face value. Independent research reported in peer reviewed journals is the most trustworthy source of information, followed by case series and case studies. However, this type of independent verification is much more rare in the supplement industry than others because of the difficulty in obtaining and defending patents. With the decreased ability to protect proprietary products comes decreased profits and decreased money for research.

Much more information is available on individual nutrients than complete products. When reviewing the current literature on nutrients, attention must be paid to the specific forms, dose, routes of administration, and measures of change used in the studies. There can be much more variation in expected activity based on these specifics than on which species was used in the study. If the ingredients in question are basic nutrients, extrapolation of results from one species to another can be reasonable.

The abstracts and keywords from most scientific journal articles are currently being electronically databased so that they can easily be searched. The easiest access for a practitioner is through PubMed through the website www.nih.gov. This search engine searches Medline for literature containing the keywords the user enters. Many equine journals are not found in this collection. Many veterinary schools and colleges of agriculture offer services so that librarians will do searches for practitioners over the phone and forward the results with abstracts by email. Requests for the full articles usually require a fee and take much longer.

What is behind the label?

Evaluation of commercial products can be very difficult. The nutritional supplement industry is very different from the pharmaceutical industry. There are several small companies instead of a few large ones. The availability of technical support by professionals with appropriate credentials is very scarce. Selection of a company can be as

important as the selection of what nutrients to supplement. When you read a company's literature was it written by the marketing department or were there people that know the science involved? When you call a company can you readily speak with a professional in technical support? Beware of "one size fits all" doses. The amount of nutrients needed by an individual is based on weight, age, and severity of the problem or deficiency. A company should be able to quickly help you use their product in a way customized to your patient. While ingredient quality is of utmost importance in a supplement, it is very difficult to verify. Unfortunately, a practitioner's clinical experiences and personal interactions with a company will yield the best indications of product quality.

General Supplements

Antioxidants

Vitamins, minerals, and other molecules, which act in the body to scavenge oxygen radicals, are antioxidants. Most patients that need nutritional support will benefit from a high level of dietary antioxidants. Antioxidants should be supplemented as a group instead of high levels of individual ones, due to the fact that any antioxidant can act as a pro-oxidant if present in high enough amounts.

Minerals

Minerals act as cofactors for enzymes for almost every reaction in the body. Everything from immune system function, to bone density, to protein, fat and CHO metabolism is affected by mineral deficiencies. Mineral supplementation should be critically evaluated. The authors suggest amino acid chelated minerals, due to the increased bioavailability of these formulations. Other organic complexes (citrate, gluconate, and lactate) have a higher biological value than the inorganic complexes (oxide, carbonate) with sulfate being in the middle. The inorganic forms of many minerals are toxic, while the organic forms are very beneficial (ex: chromium). Unless minerals are supplied in the correct balance and form, minimal benefit will be obtained by supplementation.

Vitamins

Vitamins are categorized into two distinct classes: water soluble and fat soluble. Water soluble vitamins are not stored in the body; they are excreted if not utilized soon after ingestion. Fat soluble vitamins (Vitamins A, D, E, and K) are stored and have more of a potential for toxicity.

Horses on premium commercial feeds rarely develop a clinical deficiency of an individual mineral or vitamin because the feeds are appropriately fortified. General supplements should not be used to try to make a good ration out of cheap feedstuffs. They can be used to support horses that are under more stressful conditions such as performance, reproductively active, diseased, or geriatric.

Hoof

Hoof health is often a reflection of the nutritional status of the individual. Keratin based structures such as the hoof, mane, tail and hair may reflect nutritional deficiencies long before other body systems begin to exert obvious signs. Vitamins, minerals, and specific amino acids may be spared incorporation into these structures due to the need in more biologically "important" structures. However some individuals may need supplementation for the hoof and other keratin based structures beyond what can be supplied in even premium horse feeds. In these cases attention should be given to specific nutrients that are necessary for proper keratin formation. Guidelines provided in this article for evaluation of any supplement should be applied when choosing a "hoof supplement". In addition the following is a list and short description of specific nutrients that provide the body with the basic building blocks of keratin.

Biotin: Biotin is a B vitamin that is required by all animals as a biological catalyst in numerous metabolic reactions. Biotin is involved in the keratinization process early on in the horn cell's development. Due to its early incorporation, the benefit of biotin supplementation is often not seen for months or until new hoof growth is evident. Animals with biotin deficiency present with dry and cracked skin, poor hair coats, split and cracked hooves and foot lesions. Though biotin may be the most well known "hoof nutrient" it is not the only one. Some horses supplemented with biotin alone exhibit no improvement in overall hoof health. This often suggests a deficiency in other nutrients that are integral in healthy hoof development.

Amino Acids: Lysine and Methionine are two amino acids essential for quality hoof growth. Keratin is a protein. Proteins are huge complex molecules that involve numerous amino acids for the complete formation. Proteins that lack enough of the correct types of amino acids often are not functionally sound, resulting in poor quality hooves. Methionine and Lysine are highly utilized in the horse and should be supplied in adequate amounts in the diet.

***Joint**

It was found over 50 years ago, that over time, eating ground up connective tissues could help relieve problems associated with arthritis. People began to consume gelatin and cartilage (shark, chicken, bovine, or Perna muscle) and these helped some. Studies found that chondroitin sulfates were contributing most of the beneficial effects. About 30 years ago the research began focusing in on the much smaller Glucosamine Sulphate.

Whole cartilage and its large components (chondroitin sulfates and collagen) can not be absorbed well by the body. While large molecules such as these can be injected and work very well, when taken orally more than half usually ends up in the manure. Chondroitin sulfates have a large range in size. Some are 50 times larger than others. Only 8-10% of the smallest ones have been shown to get from the gut into the blood intact. What is fed must be digested by the gut and the pieces that do get into the blood must be broken down further to get into the joints.

There are several types of glucosamine used in supplements.

Glucosamine Sulphate is the basic building block of connective tissues and fluids. Studies have shown in humans, rats, and dogs, that when Glucosamine Sulphate is given orally, within 30 minutes 87-97% is actively taken from the gut into the blood. Further, within 4 hours the chondrocytes (joint cells) have actively taken it from the blood. When linked together with sulfur, chains of glucosamines become several different types of connective tissues and joint fluid. [A lack of sulfur will cause the production of connective tissues to stop.] Also an enzyme can slightly change the shape of the glucosamine into galactosamine, the basic building block of the chondroitin sulfates. In one clinical study, where Glucosamine Sulphate was feed to horses, 77% of Navicular disease and 100% of Spavin cases returned to normal function.

N-acetyl-glucosamine has been proven to not have active uptake from the gut in vitro.

There are no studies that show if Glucosamine HCl is actively absorbed, or how much of it actually gets into the blood or the joints. Whatever portion does make it into the joints must be undergo changes before it can be used in connective tissues. The HCl must be removed and a sulphate added. Furthermore, Glucosamine HCl is not stable in liquids. Published experiments have shown that over half of the Glucosamine HCl added to a liquid solution will breakdown within 27 hours. Within 4 days, these new and different "breakdown products" form completely different molecules that were 20 times larger than what was originally in the solution.

Other non-structural ingredients are also commonly used.

Glutamic acid (glutamate) is an excitatory amino acid (EAA). When this amino acid is added to a brain experimentally it causes seizures. Higher than normal concentrations are present in the brain of human seizure patients. Research is being done to see whether blocking its activity will help control seizures. It is also being considered as an antidepressant drug. This amino acid is also naturally released by joint nerves to signal pain. It is used as an experimental marker to determine the amount of pain induced in experimental models. The more glutamate that is released, the more pain that is felt in a joint. Caution is given here because a review of this product in a popular publication discusses its dramatic and swift change in horses' attitudes. Research is currently being done to determine its role in seizures and the signaling of pain. What will prolonged use do? At what levels does this ingredient become dangerous? How addicting is it? These are only some of the questions not clearly answered by science. Glutamic acid is added to some joint supplements because the amine group in glucosamine can be donated by glutamic acid. However, providing extra of a particular AA does not mean that more connective tissue will be made.

Bromelain is an enzyme found in pineapples. It has been shown to reduce the amount of swelling present in some experimental animals. However, Bromelain can enter the body intact, because it digests the lining of the GI tract. In human cancer patients, it has been shown to stimulate the body's own immune system to kill somatic cells. Since it is a protein, it can cause allergic reactions. People who handle bromelain have become allergic to it.

Many of the "flex products" on the market contain herbs, which do not contribute nutrients to the joint tissues. While an in depth discussion of herbal ingredients is beyond the scope of this paper, the following are mentioned due to their common addition to many supplements and their serious impact on or conflict with other drugs and their potential to cause positive results on competitive drug screenings.

Yucca contains steroid saponins. Steroids have been shown to slow the production of glycosaminoglycans (GAG's). Boswellia, white willow's bark, and snake root are all herbs containing chemicals that act as NSAID's. Devil's claw contains several chemicals, which are reported to decrease pain. They do not decrease inflammation and are similar in structure to steroids. This herb should not be used with any female (human or animal), as it has been reported that Devil's claw can cause abortions, by stimulating uterine contractions.

Electrolytes

Electrolytes are not stored in the body therefore daily requirements must be met through the diet. The major electrolytes are sodium, chloride and potassium. The voluntary intake of electrolytes is balanced by the output of electrolytes in urine, feces, and sweat in normal healthy horses. Dietary loads of electrolytes increase the urine losses of these electrolytes. However, in certain situations such as strenuous exercise, diarrhea, and other gastrointestinal abnormalities; the electrolyte losses may exceed the intake. In these situations, supplementation with salt (NaCl) and Lite salt (KCl) may be necessary to offset these losses. Horses with profuse diarrhea often are affected by electrolyte imbalances, however, these needs are normally corrected by intravenous fluid therapy. Sodium bicarbonate supplementation is also necessary in some disease states and may be beneficial in exercising horses to buffer the production of lactic acid.

Horses that exercise for long periods of time and become depleted of electrolytes often benefit from oral supplementation. Not only does supplementation correct the electrolyte levels, it also stimulates the horse to drink more water. When choosing an electrolyte supplement, use a trustworthy manufacturer and make sure you are supplementing the electrolyte minerals, not just sugars.

Fats and Oils

Fats and oils make up a family of chemical compounds called lipids. Lipids that are solid at room temperature are called fats. Lipids that are liquid at room temperature are called oils. Lipids are capable of providing large amounts of energy (9 kcal/gram), twice as much as protein and carbohydrates on a per gram basis (4 kcal/gram). For this reason it is often advantageous to supplement lipids in the form of oils when an individual is in need of extra energy. Less heat is produced as a by-product of fat digestion. This is beneficial in climates with high heat and humidity. In equine rations, animal sources of fats, such as tallow, are between 88 and 92 percent digestible; whereas plant sources, such as corn or soybean oils, are around 94 percent digestible. Corn oil is the most palatable lipid supplement for horses. Fat should be added to the diet gradually ($\frac{1}{4}$ cup per meal initially and increase by $\frac{1}{4}$ cup every three days). Horses may require up to 6 weeks to adjust their metabolism to the increased fat utilization. Higher fat diets (20-25%) have been shown to enhance fatty acid oxidation in horses that have been adapted to this diet. The enhanced fatty acid oxidation decreases the production lactic acid during exercise.

There are also specific disease conditions where a higher fat diet is beneficial in preventing signs of the disease such as polysaccharide storage disease and inflammatory bowel disease. Fat supplementation should be excluded in the face of diseases involving liver function or altered lipid metabolism.

Another potential benefit of supplementing lipids is the addition of fatty acids. Though little work has been done with fatty acids in horses, other species have shown great benefit when certain fatty acids levels are increased, especially linoleic and alpha-linolenic. The sources of fat are higher in these fatty acids (omega 3 vs. omega 6) produce less inflammatory mediators. Changing the fatty acid ratios in the diet may be beneficial in reducing the inflammatory response, but more research needs to be done to prove benefits of ongoing supplementation of equine rations.

***Reproduction**

Several vitamins and minerals are associated with increased reproductive performance in both males and females. As mentioned earlier, the form that minerals are supplied in is critical. All of the minerals listed below have reported toxic effects on reproduction, when exposure is to the inorganic forms, and beneficial effects when exposure is from organic forms.

Biotin is a water soluble vitamin that has been heavily researched in many species with respect to its effect on female reproductive performance parameters and gamete development. The most well documented effects are on sow conception rates and return to estrus post parturition. Many effects of biotin on prenatal development have also been established.

Boron is an ultra-trace mineral that is a good example of a nutrient that is beneficial to the spermatogenic cycle, embryonic, and fetal development when provided in an organic form. However, if the exposure is to an inorganic form, testicular damage and mutagenic effects are common. Boron is involved in the production of many sex hormones.

Chromium is also an ultra-trace mineral whose deficiency can cause a decrease in sperm count, but exposure to inorganic forms can cause severe testicular damage, improper testicular development, or neoplasia. Many positive effects on female reproductive efficiencies and lactation improvements have been found.

Folic acid is a water soluble vitamin that plays critical roles in the normal reproduction of cells. A deficiency of folate has been associated with defects in pre-implantation embryos and the neural, skeletal, digestive and urinary tracts of developing fetuses.

Manganese is a trace mineral that is essential for growth, reproduction, prevention of skeletal abnormalities, and congenital ataxia. Mn usually localizes in the cell's mitochondria. Mn is the metal cofactor (preferred) for a number of glycosyltransferases which provides the link between biochemical function and deficiency symptoms. Mn also plays an important role in carbohydrate, lipid, and brain metabolism. Research has shown that manganese plays a large part in attachment and conception. Exposure to inorganic Mn causes extremely reduced male fertility.

Thiamine is a water soluble vitamin that is crucial to the viability and motility of sperm. Normal development in the uterus depends on the presence of thiamine.

Zinc is a trace mineral whose deficiency has negative effects on testosterone levels and sperm development. Normal growth and lactation are both dependant on the presence of enough zinc. Exposure to inorganic zinc causes harm to male and female reproductive tissues.

Amino Acids and Protein Supplements

Protein supplementation can be used to support patients with chronic diseases that are in catabolic states. They can also be given when protein is being lost in an abnormal fashion. If protein supplementation is undertaken, the main selection criteria is biological value of the protein delivered. The main concern with over supplementation of protein or supplementation of lesser quality proteins is the production of toxic waste products such as urea and ammonia. Whey protein is of very high value and is also very economical.

Creatine is an amino acid that provides an energy source for muscle contractions by providing phosphorus to ADP to form ATP. Creatine's contribution occurs during periods of ultra short duration, high exertion. Supplementation of human athletes has shown benefits only in activities such as weightlifting, even sprinting appears to be too long of a duration. Supplementation of horses with creatine has not been shown to improve performance.

Arginine, carnitine and glutamine contribute to glycogenesis. Arginine is also capable of accelerating wound healing and inhibiting the development of some neoplasias. Studies on arginine supplementation have shown significant decreases in recovery time from both trauma and surgeries due to its effects on blood flow, immune function, wound healing, and organ failure.

Carnitine stimulates protein synthesis in the face of stress and may accelerate fatty-acid oxidation, which lowers lactic acid production. Carnitine has also been shown to reduce hepatic fat in several species, via increased production of lipoproteins.

***GI**

Pre- and probiotics: Prebiotics are ingredients that when provided to the digestive tract selectively support the growth of beneficial bacterial species over pathogenic ones. Prebiotics do not directly colonize the digestive tract. Prebiotics include yeast, yeast cultures, fungal cultures, and certain fibers (FOS-fructooligosaccharides). Probiotics are the bacterial species that, when introduced to the digestive tract, actually colonize and produce beneficial effects. Synbiotics are products that contain both prebiotic and probiotic ingredients. Ingredients of these types are very important to include in a nutritional support program when the digestive tract is being stressed by changes in ration, environment, location, activity level, etc. Fecal transfer from a healthy donor is a viable way to reintroduce viable microorganisms to the gut environment.

N-acetyl-D-glucosamine: A structural component of all mucosal surfaces. Supplementation with N-acetyl-glucosamine may help firm up the structural matrix of the intestinal tract. Though glucosamine appears to be highly absorbable, N-acetyl-glucosamine is directly incorporated into the intestinal mucosa and is not absorbed when provided orally. This improves the overall health of the intestinal tract under stress thereby contributing to its healing and increased absorption of other nutrients.

Glutamine supplementation should be incorporated to meet increased energy needs of the enterocytes in diseased or stressed states. 80% of the dietary intake of the amino acid glutamine is used by the enterocytes as energy in normally functioning digestive tracts. Increased intakes will support cell replication and function.

Arginine has been found in human burn patients to promote the release of intestinal hormones and growth factors in the intestinal tract when given orally. It also increases blood flow to the digestive tract.

Disclosure: J. Eric Martin, D.V.M. is V.P. of Research and Development and David F. Davenport, D.V.M., M.S. (Ag. Econ.), M.S. (Nutr.), C.N.S. is CEO of MD's Choice, Inc which sells individual and combined nutrients that are used in supplements such as those described in the above paper.

*Denotes categories in which MD's Choice, Inc. sells products.

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