The Power of Protein

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Of all the components of your horse's diet, protein is probably the most misunderstood. Long assumed to be an energy source, protein actually has quite a different function—it provides amino acids. Amino acids are the building blocks of bones, muscles, and virtually all of the body's soft tissues, for growth and repair.

This makes protein an essential part of the diet, but it does not necessarily mean that more is better. Growing horses, which are "building" new tissues as they mature, and horses being used for breeding have a higher protein requirement than do mature horses, whether working or idle. Mature horses have surprisingly low protein needs. And while protein can serve as an energy source, it's a poor one in comparison to carbohydrates and fats, which the horse can metabolize far more efficiently. This information is slowly changing the way we formulate equine diets, as well as the way we think about which protein are appropriate for our horses.

Inside A Protein Molecule

Proteins are "chains" made up of various combinations of the 22 different amino acids that exist in nature. Amino acids are relatively simple organic compounds, consisting of a basic amino group (described in chemical shorthand as COOH) and an acidic carboxyl group. Carbohydrates and fats also contain carbon atoms with hydrogen and oxygen atoms attached, but amino acids alone contain nitrogen and sometimes sulfur. The position and number of the amino acids in a single protein make up its "amino acid profile" (more on this later).

When a horse ingests protein, the chain of amino acids is broken up in the digestive tract by enzymes and acids, and the individual amino acids are absorbed through the wall of the small intestine and into the bloodstream via the liver. From there, they travel to the sites where they are needed most for growth or repair of tissues.

Although amino acids are absorbed from the small intestine relatively unchanged from their original chemical composition, the horse's body does have the ability to change some amino acids into different formats as the need exists, a process which occurs in the liver. However, the body does not have the ability to create all the amino acids it needs. Some amino acids can be synthesized only by microorganisms or green plants. These are called the "essential" amino acids, and they must be obtained by the horse from its environment. ("Non-essential" amino acids are those the horse can synthesize itself.)

A quality protein source is one that provides a sufficient amount of these essential amino acids, particularly the amino acid lysine, which often is called the "first limiting" amino acid (meaning that if insufficient quantities of lysine are present, the horse's body will have difficulty using any of the other amino acids available).

What are amino acids good for? Virtually all of the horse's vital processes, it seems. They are involved in the synthesis and the release of hormones, the synthesis of neurotransmitters and enzymes, and the regulation of sleep, appetite, and blood pressure, to name just a few functions. But primarily, amino acids are needed for the formation and repair of muscle tissue and other soft tissues throughout the body. On a fat-free, moisture-free basis, they account for approximately 80% of a horse's total structure.
The amino acid profile of a feed is more important to a young, growing horse, than to a mature one; adult horses are far less sensitive to differences in protein quality. Nor does it matter to the horse whether a particular amino acid comes from a natural source or whether it is chemically synthesized. Lysine and methionine are two essential amino acids that often are deficient in horse feeds, and because they can be synthesized inexpensively, it’s quite routine for feed companies to add these ingredients to improve the overall amino acid profile biochemically. (Not all amino acids can be synthesized easily, however.)

Can protein serve as an energy source? Well, yes, but metabolically, it's an expensive process, producing three to six times more heat than the breakdown of carbohydrates or fats, and yielding considerably less energy. The heating factor might be beneficial in a cold environment, but it also can contribute to excessive sweating and possible heat exhaustion during hard work, especially in a warmer climate. And because protein is one of the more expensive ingredients in a feed, it's very impractical to feed higher levels of protein in search of a performance advantage. You'll do far better by upping the levels of carbohydrates and fats.

Assessing Protein Levels

Most of us determine a feed’s protein level by looking at the percentage value on the feed tag under “crude protein.” But the crude protein numbers do not really reflect either a protein’s overall quality (which can be determined only by the amino acid profile), or the amount of protein from that feed a horse can digest and use. The crude protein value is based on the overall nitrogen content of a feed, and not all of the nitrogen in a feed sample is necessarily protein-bound. Nitrogen also might be found in purines, creatinine, ammonium salts, and nucleic acids, all of which might be in a feed sample. In cattle feeds, a common non-protein source of nitrogen is urea, which is added to help cattle synthesize their own proteins when the nitrogen is made available in their guts. Urea also can be found in some horse feeds, but horses are not equipped to use it the way cattle are; it does no harm, but also has no benefit.

Feed companies calculate the crude protein value of a feed based on a chemical analysis of the overall nitrogen content. Based on the idea that most proteins contain about 16% nitrogen, plus or minus 2%, the nitrogen content of a feed is divided by 0.16 (or multiplied by 6.25 for the same result) to arrive at the crude protein (CP) value. For example, if you know a feed has a nitrogen content of 1.6%, the crude protein of that product would be 10%.

The possibility of non-protein-bound nitrogen sources in the feed is what makes the CP level an estimate, at best, of what the horse actually can digest and use. As a rule, you can estimate that most grain products are somewhere between 2% to 5% lower in digestible protein (DP) than the CP numbers indicate. A product that is described as being 14% crude protein would probably deliver 9% to 12% DP. The difference is more dramatic with hay--depending on the stage of bloom in which it was cut; sometimes only about 50% of the protein in hay is digestible.

The availability of amino acids in a grain ration can be affected adversely by denaturing or oxidation as a result of long storage (particularly in warm conditions or bright sunlight) or improper heating (as can sometimes occur during a pelleting or extruding process). Inadequate drying of a heated feed, prior to storage, also can reduce the protein digestibility. Some feed companies anticipate these problems with feeds that undergo heat processing and add supplemental levels of lysine (and sometimes other amino acids as well) to compensate.

Excesses And Deficiencies

Horses which receive inadequate amounts of protein in their diets can suffer a number of ill effects, including decreased growth and development in youngsters, and reduced appetite, body
tissue loss, slow hoof growth, energy deficit, and a poor hair coat with reduced shedding in adults. Muscle deterioration, especially in the large muscle groups of the hindquarters, also might be evident, and some horses will begin eating manure. The reduced food intake of a depressed, protein-deficient horse can become a vicious cycle, as it makes it difficult to remedy the condition with a correct diet. But the protein requirements of an adult horse are low enough that true protein deficiencies are quite rare; they usually occur only when a horse is on very poor pasture or hay with no other supplemental feed for a prolonged period of time. With a corrected diet, most of the signs of protein deficiency in adult horses can be turned around in as little as a week. The damage done to a young, growing horse, however, can be more serious.

More common, and as equally damaging, is an excess of protein in the diet, especially in mature horses which have been fed by owners laboring under the misunderstanding that protein equals energy. Here's what happens: Protein which is not used immediately by the horse's system is broken down to release the nitrogen atoms (the rest of the molecule being stored), and those nitrogen atoms become bound up as ammonia and urea molecules. The ammonia and urea eventually are excreted in the urine, which leads to increased water intake, increased urination, and a noticeably strong ammonia smell in the stall. (Some researchers suspect that feeding excess protein, coupled with the confined lifestyle of the average racehorse, might be contributing to the high incidence of exercise-induced bleeding of Thoroughbreds and Standardbreds--standing in a stall breathing high levels of ammonia can be very irritating to the respiratory passages.) Before ammonia and urea can be excreted in the urine, they must be filtered out of the blood--which, over time, can tax the kidneys. It's conceivable that this eventually might lead to decreased renal function, which means the unfiltered urea and ammonia in the bloodstream can exacerbate liver and kidney disease.

Decreased athletic performance is another possible outcome of a high-protein diet. In addition to all this, there's some evidence that excess protein can interfere with calcium absorption. Researchers do differ, however, on how much damage a high-protein diet can cause, and how long a horse must be fed such a diet before the effects (if any) are noticeable. There is stronger evidence for the detrimental effect of excess protein in growing horses. In one study, weanlings and yearlings fed a diet 25% higher in protein than normal suffered slower rates of growth overall and a higher incidence of developmental bone and joint problems.

How Much Is Enough?

So what is an appropriate level of protein for your horse? Continuing research is changing that answer all the time, but there are some general guidelines.

The amount of crude protein needed in the diet depends on the needs of the individual horse (most importantly, is he still growing?), the digestibility of the protein, and the amount of the diet consumed. The accompanying chart gives some recommended values for horses in different stages of life. Generally, a value of 0.60g of digestible protein per kilogram of body weight per day is appropriate for most adult horses.

Broodmares in their first eight months of gestation don't really need supplemental levels of protein, but in their last trimester, when the fetus does 60-65% of its developing, their protein requirements increase. Lactation (milk production) also demands higher protein levels; the protein content of mare's milk is highest right after foaling, and it decreases gradually as the lactation period progresses. After three months of producing milk, most mares are producing fairly small amounts (and foals are starting to eat more solid food), and a return to their regular protein levels usually is appropriate.
Some researchers feel that breeding stallions also can benefit from a higher level of dietary protein, which is scaled back once breeding is finished for the year.

Hard exercise (such as racing, three-day eventing, or endurance racing) does increase the need of adult horses for protein in the diet to support increased muscle development and mass and to replace nitrogen lost in sweat. But the overall increase is quite small--just 1% to 2%

Which feeds provide the best protein? Interestingly, animal sources, such as milk and egg protein, and even fish and meat meal, provide the best amino acid profile and the highest levels of lysine. Milk protein often is used as the primary protein source for foal feeds, but because it is quite expensive (and because adult horses are far less sensitive to protein quality differences), it's rarely found in feeds for mature animals.

Among the plant sources, soybean and canola meal are the next best thing--they are the only two plant protein products that contain adequate amounts of lysine and methionine. Other common protein sources, such as linseed and cottonseed meal, have poor amino acid profiles and are generally supplemented with amino acids added by the feed manufacturer. Grains themselves (such as oats, corn, and barley) can contain between 8% to 20% protein, but it's of poor quality, which is why most feed companies add a higher-quality protein supplement to their "balanced" feeds (sweetfeeds, pellets, and other pre-mixed rations). If the manufacturers have done their job, the feed should contain at least 0.65% lysine (on a dry matter basis) when they're done. If this level isn't present, more feed will be required to get the same results (particularly with young, growing horses).

Like anything else, delivering the correct amount of protein to your horse is a matter of reading the feed tags, doing your homework, and practicing some moderation! While protein is a crucial part of your horse's diet, it has to be put in perspective--as just one part of a working whole in the nutrition scheme.