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HARD TO FIND NUTRIENTS FOR RATION EVALUATIONS: FILLING IN THE HOLES

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Meaningful ration evaluations are as dependent on the values for the nutrient concentrations of the feed ingredients used as they are on the estimation of the nutrient requirements of the horse. Accurate and complete sets of nutrient values for the feed ingredients used in horse rations are seldom published. If ration evaluations are to stay current as recommendations for horse requirements are updated, more emphasis must be placed on creating and maintaining a database of ingredients used in horse rations.

Information that is currently available has been borrowed from information used in other species. Ingredients that horse rations share with the monogastric diets are well documented for their vitamin, mineral and amino acid content. The fiber contents of ingredients common in ruminant diets are also well documented, although the fiber component most often used in ruminant calculations, acid detergent fiber (ADF), falls short of being a complete analysis for equine diets. This leaves some holes in information that is available to include in equine diets. Many of the forage ingredients that are common in equine diets are not common in ruminant diets and have not been routinely analyzed for the fiber components. These same ingredients are even less common in monogastric diets and are therefore seldom analyzed for amino acid, mineral or vitamin content. It will be the responsibility of those using these ingredients in horse rations to accumulate the information to fill these holes.

Values for nutrient concentrations to be used in a ration evaluation can come from one of four sources.

Laboratory analysis of the ingredient

Chemical analysis of a feed product or ingredient can supply values for many of the nutrients that are used directly for ration evaluation. Most of the mineral components as well as the protein levels can be measured directly and the results used as reported for formulation. This is the method of choice for ingredients that are unique to a specific ration, such as when a client uses a particular local hay. Nutrients that are usually measured directly and used for the evaluation are dry matter, protein, calcium, phosphorus, magnesium, sodium, potassium, copper, zinc, manganese and iron.

Laboratory analysis of the ingredient with a calculation

Some nutrients are not measured directly by lab analysis but can be calculated from the results of related measurements. Energy, although not a single nutrient by definition, is used as one in most ration evaluations. Energy cannot be measured directly in the laboratory, so it is calculated from the values of nutrients that can be measured directly and contribute to the energy-producing characteristics of that feed. Amino acids can be measured directly for a feed sample but for single samples are more often calculated using the crude protein measurement and a calculation of the normal amino acid concentration in the particular feed.

Feed composition tables

Values used in evaluations can be taken from feed composition tables for the ingredient that most closely resembles the one being used. The values can be from printed tables like those published in Nutrient Requirements of Horses (NRC, 1989) or the default values supplied in formulation programs. Tables produced for use with other species can be used if care is taken so that the units used to quantify the nutrients are appropriate for horses.

The guaranteed analysis of a product

Any commercial product must have a guaranteed analysis for some nutrients. The nutrients that are guaranteed are dependent on the regulation that is applicable in the state where they are to be sold. These guarantees are usually very limited in number and by no means a complete list of nutrients in the product. Published promotional literature of commercial products often has a more complete list of nutrients than that of the guaranteed analysis.

Calculations to be Used in Conjunction with Laboratory Analysis

Energy

The variation in energy content of the feed ingredients causes greater adjustment to the formulation of equine diets than any other nutrient. The lack of a direct measurement of energy necessitates the estimation of the energy content from the nutrient fractions that can contribute to the total energy-creating potential of the feed ingredient. The more detailed the partitioning of these fractions by laboratory analysis, the more accurate the estimate of the energy content of that ingredient. Some discussion continues about the best system of estimating the energy content of ingredients from chemical analysis. It is important to note that whatever system is used to estimate the energy content of the ingredients must match the system used to estimate the requirements of the horse. A direct measurement of the ability of the horse to derive this calculated energy must be in the loop somewhere. The principle for each of these systems is similar. An estimation of each nutrient fraction that will contribute to energy production by the horse can be made by chemical analysis. The energy-generating capability of each fraction is estimated. The sum of these fractions represents the total energy content of that ingredient. The equations used to estimate the energy content from the chemical components are numerous and vary to match the nutrient fractions that are available from laboratory analysis for entry in the equation.

Equations used to estimate the digestible energy content of feeds for horses.

Parameters needed	Equation to estimate energy DE
ADF	DE = 3.57 - .0401 ADF
NDF	DE = 4.88 - .0769 NDF + .0489 NDF^2
ADF, CP	DE = 4.22 - .111 ADF + .0332 CP + .00112 ADF^2
NDF, CP	DE = 5.18 - .0783 NDF + .0491 NDF^2 - .0199 CP
ADF, NDF, CP, EE, NSC, Ash	DE = 2260 + 14.17 CP - 11.48 ADF - 4.88 (Hemicellulose) + 57.2 EE + 24.38 CHO - 31.77(Ash)
TDN	DE = .255 + .0366 TDN
DDM	DE = .273 + .0351 DDM

ADF= acid detergent fiber, NDF= neutral detergent fiber, CP = crude protein, TDN= total digestible nutrients, CHO = soluble carbohydrate, EE = ether extract, DDM= digestible dry matter, hemicellulose = NDF-ADF

Amino acids from protein

The protein concentration of most feedstuffs is well documented. Analysis of the protein content of forages and grains is more common than any other laboratory test. However, analysis of the amino acid profile of the feeds for equine diets is rare. The amino acid profiles of the ingredients used in monogastric diets, mostly the grains, are well documented. Values for these ingredients can be taken from feed composition tables and used directly in the evaluation. The values for forage products are more difficult to find. As forage can be a large proportion of the equine diet, values for these ingredients must be estimated if a meaningful comparison is to be made with the daily requirement of the horse. The only amino acid with established and widely accepted requirement levels for horses is lysine. In the absence of absolute values for lysine, an estimate calculated from the crude protein level of the ingredient and usual lysine content of the protein found in that ingredient is preferable to using a value of zero or leaving the entry blank. Additional tables and calculations will be needed if other amino acids are to be used in equine ration evaluations. The following are equations that can be used in the absence of known or tabular values for lysine when the crude protein level is known.

Feed type	**Equation to estimate lysine from crude protein**
Alfalfa hay	Crude protein x .042
Clover hay	Crude protein x .050
Timothy hay	Crude protein x .030
Bermuda grass hay	Crude protein x .035
Bluegrass pasture	Crude protein x .027
Oat hay	Crude protein x .031
Corn silage	Crude protein x .051

Acid base balance from macrominerals

The concentrations of the minerals sodium and potassium are well documented in most ingredients used in horse rations. Even in the absence of tabular values for these minerals they are routinely measured directly by laboratory analysis. The horses' requirements for these minerals are stated as absolute amounts per day or as concentrations within the total diet. For these requirements, the calculations can be made. There is increasing interest in the acid base balance of horse diets. For this calculation the values of the other strong anions, chloride and sulfur, must also be included. To date no specific requirement for chloride has been used so the chloride values of many ingredients used in equine rations have remained unreported. The chloride content of ingredients can be analyzed in the laboratory but is seldom included in the analysis packages. The tabular values for these minerals will become more available for forage ingredients as the dairy industry uses the acid base calculations in ration formulation. The chloride content of some common feeds in horse rations is as follows:

Feed	Chloride concentration %
Alfalfa hay	0.31
Grass hay	0.46
Oats	0.13
Corn	0.04

Trace Minerals not Determined by Lab Analysis and Seldom Listed in Tables

Selenium

Selenium is seldom included in the mineral analysis package of most forage laboratories. The specialized procedures needed to accurately test for selenium make this test cost prohibitive for most individual samples. The selenium content of plant materials is directly proportional to the selenium level of the soil in which the plant was grown. For this reason tabular values for selenium are less precise than other minerals unless the feed composition table is specific to a given region. Localized information available from agronomy extension agents can be a valuable resource for estimating selenium content of feed ingredients grown within a specific region.

Iodine

Iodine levels of feed ingredients are rarely complete in feed composition tables. Laboratory procedures to analyze iodine in feed ingredients for a single sample or ration evaluation are usually cost prohibitive. Testing for iodine is seldom included in forage analysis packages. When iodine levels are reported for feed ingredients, the unit of measure is often to only one decimal place of parts per million. If the requirement for iodine is reported at 0.1 ppm, the reporting of any iodine in the forage portion of the diet would fully meet the requirement. For iodine to be meaningful in ration evaluations, the accuracy of both the reporting of the nutrient levels and the requirements may need to be reassessed.

Vitamin A

Vitamin A levels reported for feed ingredients are not a direct measurement of vitamin A content but a calculation of the carotene content multiplied by a conversion factor. In the NRC requirements for horses the conversion factor used is 400 IU of vitamin A for each g of carotene. Vitamin manufacturers suggest using different conversion factors for each ingredient and for animals of different species and ages. This single conversion factor would suggest that diets containing a majority of the ration as alfalfa would need no additional supplementation of vitamin A. Research has shown that such a diet would not equal the performance of a diet with added vitamin A. For ration evaluations containing a large percentage of alfalfa, the use of this conversion factor will always show the vitamin A supplied far in excess of the requirement. This is not a concern if this excess is from the inclusion of carotene in the diet. However, if these apparent excesses from carotene calculations mask an oversupply of formed vitamin A or cause complacency towards oversupplementation of vitamin A, the validity of the ration evaluation may be compromised.

Vitamin E

Vitamin E contents of forages used in horse diets are seldom analyzed but are often reported in feed ingredient tables. The forage ingredients of the diet often meet the vitamin E requirement for normal health and well-being very easily. The increased demand for vitamin E as an antioxidant in performance diets is most often not dependent on the forage portions of the diet; the higher levels of vitamin E intake will usually come from the supplemented part of the diet. Vitamin E is one of the more expensive nutrients added to equine rations so oversupplementation of diets because of inaccurate or missing values during ration evaluation can be critical.

Feedstuff	**Vitamin E (IU/kg)**
Alfalfa hay	40
Clover hay	40
Timothy hay	30
Oats	15
Soybean meal	3
Wheat middlings	20
Grass hay	10

Nutrients that May be Used in the Near Future for Ration Evaluations

Fatty acid components of rations

At present there is no requirement set for the amount of fat in a horse's diet and no requirement for any specific fatty acid as there is for linoleic acid in other species. The pet food industry now pays very close attention to specific fatty acid components of the diet. The commercial poultry industry is also concerned both with feeding a minimum amount of a given fatty acid and the ratio between fatty acids in the diet. To make adjustments like this in horse rations, more complete values for the nutrients in ingredients commonly used in equine diets will be needed. One ratio that is currently being used in other species is the ratio of omega 3 and omega 6 fatty acids within the diet. Common equine rations would be proportionally high in omega 6 fatty acids and almost devoid of omega 3. Most of the ingredients that would be used to manipulate this ratio would have known levels of all fatty acid components. Quantifying the amount of omega 6 in the basal ration would be necessary to calculate the ratio. Values for fatty acid composition are published for most ingredients that are used in human and monogastric diets. However, there are few published figures for the fatty acid content of the forages which will always comprise a significant portion of horses' diets. As these are ingredients that are not commonly used in diets for any other species for which fatty acids requirements are established, tabular values will not be soon coming. The responsibility of analysis for these nutrients will fall to those who use them in feed formulation.

Chromium, boron, aluminum and silicon

Chromium, boron, aluminum and silicon are all minerals that will have an increasing visibility in equine diets. All of these minerals are required in amounts less than the microminerals that are currently added to equine diets. The technology is available to analyze for these minerals in feed ingredients and values are sometimes listed in feed composition tables. In spite of this, the concentration of these minerals in the feed ingredients will have little effect on the formulation of feeds. The measurement of the elemental levels of these ultra trace minerals is of minor importance compared to their chemical form. If these minerals are to be added to the diets, they will be in specific chemical form. The absolute levels of these minerals are a concern only if they are suspected of being in excess and potentially toxic. Although they may be added to equine diets as complexes in the future, the level in feed ingredients should have little effect on feed formulation.

As progress is made in updating the horse's requirements for other nutrients, information on the nutrient composition of feed ingredients used in the diets may lag behind. This may prevent the widespread use of equine nutrition advances by those formulating equine rations. These less common nutrient values may be accessible for the ingredients that horse diets share with monogastric diets. Some of the carbohydrate fraction partitioning of forages to estimate energy can be found in information from the dairy industry. Documenting the new nutrients of interest in ingredients that are exclusive to horse diets will be the responsibility of the same people formulating and evaluating horse rations in the future.

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