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Paul Q. Guyer
University of Nebraska - Lincoln

Foster G. Owen
University of Nebraska-Lincoln, fowen103@gmail.com

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Composition of Feeds in Relation to Cattle Nutrition

This NebGuide examines the major nutritional components of cattle feed.

Paul Q. Guyer, Extension Beef Specialist
Foster G. Owen, Extension Dairyman

Plants serve as the major source of feed for livestock. Nutrients required for maintenance and production are provided by various plants and plant derived feeds along with small amounts from non-plant sources. The major constituents of plants are water, carbohydrates, protein, fat, minerals and vitamins. Both plants and animals contain these nutrients, but the relative proportions vary more in plants.

Water

Water content causes great variation in economic value of feed because it dilutes the nutrients. A good example is the value of alfalfa silage compared to alfalfa hay. Wilted alfalfa silage contains about 65 percent moisture while alfalfa hay contains about 12 percent moisture. If chopped alfalfa hay is worth $45 per ton, wilted alfalfa silage is worth about $17.90 it comes from the silo.

Another frequently encountered problem is comparing the value of dry vs high moisture corn, for example 14 percent moisture corn and 20 percent moisture corn. If 14 percent moisture corn is worth $2.50 per bu, then 20 percent moisture corn would be worth $2.33 per bu minus any additional cost incurred due to its high water content.

Comparisons of feeds should be on the basis of nutrients contained per unit of dry matter, thereby removing the influence of water. On the other hand, high moisture feeds may be valuable in reducing

dustiness in some rations.

Protein

Proteins are complex compounds composed of amino acids. These amino acids contain nitrogen in addition to the carbon, hydrogen and oxygen, which constitute carbohydrates and fats. When all the different proteins are considered, their average nitrogen content is about 16 percent. For simplicity in evaluating feeds, the nitrogen is measured and then converted to protein by multiplying by 6.25 (100 divided by 16). In using this method of estimating crude protein content in feeds, non-protein nitrogen compounds such as nitrates and urea are also credited toward the protein value.

Digestible protein is reported in some feed composition tables. However, many requirement tables now list only crude protein because it is more accurate for calculating quantity of protein required in mixed rations. It is also much simpler to use crude protein in using individual feed analyses in ration formulation.

Analyses can be made that will help in determining the presence of unavailable (indigestible) protein. Feedstuffs, especially medium moisture silages, often undergo heating during storage which causes some proteins to become bound to carbohydrates. This protein is not digestible. Analysis for acid detergent fiber nitrogen can be used to adjust forage protein values for this unavailable protein.

Microorganisms in the rumen assist in providing the total protein and individual amino acid requirements of ruminants. Microorganisms are able to synthesize protein and amino acids from nonprotein nitrogen (NPN) compounds, such as urea and ammonia. When the digestible energy content of the ration is high enough, 1/3 or more of the total protein needs of many ruminant rations may be supplied by nitrogen from nonprotein nitrogen sources. Growing and finishing cattle weighing over 550 lbs can effectively use nonprotein nitrogen.

Young cattle and dairy cattle, however, have limited ability to use NPN, apparently because the microbial protein formed in the rumen is inadequate in quantity or quality, or both.

When cattle over 550-600 lbs are fed high energy growing or finishing rations, nonprotein nitrogen can supply all the needed supplemental protein equivalent needed without appreciably affecting rate of gain or efficiency of feed utilization.

In low energy calf growing rations and beef cow maintenance rations, urea is not very effective as a protein substitute, especially when it is fed once daily or less often. For dairy cow rations, some urea can be fed in complete rations designed for medium and low producers. Urea does not appear to be effective in rations designed for high producers.

The concept of feeding higher levels of protein which escape rumen degradation is relatively new and needs further refinement and simplification before becoming practical for ruminant ration formulation.

The protein content of roughages is an indicator of digestible energy content. Roughage with lower than average protein (for its kind) will usually be more mature, higher in fiber and lower in total digestible energy and vice versa.

Energy

Energy in feedstuffs is carried primarily in the carbohydrate and fat fractions. Proteins also supply

energy when fed in excess of protein needs.

Carbohydrates

Carbohydrates supply most of the energy needed by cattle. Carbohydrates make up 65 to 75 percent of the dry weight of most grains, forages, and roughages. They include sugars, starch, cellulose, hemicellulose and lignin.

The two carbohydrate fractions commonly used in evaluating the carbohydrate content of feed are crude fiber and nitrogen-free extract (NFE). As crude fiber increases, digestible energy usually decreases. In most concentrate feeds, crude fiber is the less digestible portion and NFE the most digestible portion of the carbohydrates. However, in some roughages, the crude fiber fraction is as digestible as the NFE. In fact, the indigestible lignin of plants appears largely as NFE. Although crude fiber is a poor absolute measure of feed value of a roughage, it is related to digestibility of roughages and therefore is of some useful value.

New methods of analyzing for fiber have been developed. Neutral and acid detergent fiber clearly differentiate between actual fiber (cellulose, hemicellulose and lignin) and non-fibrous parts of the plant. These methods are not widely used by the feed or livestock industries, which still rely on the use of crude fiber and NFE. They will be used increasingly as more data are generated on forages.

Microorganisms in the rumen use fibrous materials such as cellulose and hemicellulose as energy sources. Because of bacterial fermentation of cellulose and hemicellulose to fatty acids, ruminants can utilize roughages and forages as sources of energy better than non-ruminants. Feeds high in cellulose can furnish most of the ruminant's energy needs when only small amounts of energy are needed above maintenance.

In the past, a minimum amount of crude fiber (about 6.0 percent) was thought to be needed in ruminant rations for proper rumen and gut function. Recent success with high or all concentrate, low fiber fattening rations points to the need for reappraisal of the fiber needs of beef cattle.

Fat

Fat is a good source of energy and is analyzed in complete feed analysis as ether extract. Fats in the ration aid in the absorption and transportation of fat-soluble vitamins (A, D, E, K). In concentrates, the ether extract consists largely of glycerides of fatty acids which provide about 2.25 times as much energy per unit of weight as carbohydrates. However, in many species of forbs and shrubs, such as sagebrush, various oils and resins are present in considerable amounts, and in all green forages considerable ether soluble pigments are present. These are extracted by ether but do not furnish available energy to the animal.

Fat is generally low in forages and most roughages, but it can be an important source of energy in concentrates. When animal fats are low in price, adding fat up to 5 percent of the total ration may supply a practical source of energy. The fat content of range cubes may be important because of its effect on palatability of the cube. Solvent processed meals, without added fat, often produce a hard, unpalatable cube which may be refused by livestock. Certain fats and fatty acids have been effective in improving intake of energy and milk yield of dairy cows.

Energy Values

Energy values are usually expressed in feed composition tables as total digestible nutrients, metabolizable energy, net energy for maintenance and net energy for gain or lactation. These values are based on digestion or balance trials for certain feedstuffs. For others, values are calculated by formulas derived from basic digestion or energy balance data. Because of this and the fact that many feeds deviate from averages, energy values should not be considered absolute. When a feed appears to deviate substantially from normal, adjusted energy values should be used in formulating rations. The best estimate of the energy value of a feed is that derived from determining *in vitro* dry matter digestibility where this analytical service is available. Energy values estimated from protein and crude fiber are useful if appropriate formulas are used in their calculation. The additional cost of a proximate analyses does not appear justified for calculating the energy value of a feedstuff.

Minerals

Minerals remain as ash after the feed has been completely burned. Ash shows the total mineral content of the feed. It is used in determining the proximate analysis of feeds and can be used to estimate contamination of a feedstuff with dirt.

Minerals are needed to form skeletal structures, for digestion, and in metabolic processes within the body. Seven major and six trace minerals are known to be essential for livestock, and several additional trace minerals are believed essential. Although trace minerals are required in very small amounts, adequate levels are just as important as adequate amounts of the major minerals.

Excesses of minerals may be harmful and cause lowered production or even death (selenium, molybdenum and fluoride are examples). Sodium and chlorine (both supplied in common salt), calcium and phosphorus are minerals most likely to be deficient in cattle diets. In addition, cobalt, copper and zinc may often be deficient in high concentrate rations if not supplemented.

Vitamins

Vitamins are needed by livestock for various body processes in very minute amounts. About 14 different vitamins are recognized to have specific functions in animal metabolism. Under normal conditions vitamin A is of major concern for producing cattle. Vitamin D supplementation will likely be needed in housed animals that get very little sunlight. The others are either produced in the healthy ruminant within the body, by rumen bacteria, or are normally present in natural feedstuffs.

Properly harvested current year's forage contains carotene, which is converted to vitamin A by the normal body processes. Cattle fed liberal amounts of good quality current year's roughage usually require no supplemental vitamin A. Prolonged storage of feeds or excessive bleaching during curing destroys carotene.

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