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Estimating digestibility of livestock feedstuffs

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Quick facts

- Much data have been collected and analyzed in an effort to correlate some chemical component of a feedstuff with actual digestibility or energy value.
- From these data, equations have been developed as a means of predicting feeding value of a feedstuff from a chemical analysis.
- Legumes have a different formula from non-legumes because of their higher protein content.
- Non-legumes are such things as meadow hays, sudan, corn stalks, grasses, etc.
- The high grain content of corn silage creates a different formula for estimating the nutritive value as compared to those for legumes and non-legume roughages.
- Estimates of total digestible nutrients can be used to balance rations and set up a livestock feeding program.

Determining the nutritive value of a given feedstuff is a time-consuming and costly exercise if actual digestive trials are employed. However, during the past few years much data have been collected and analyzed in an effort to correlate some chemical component of a feedstuff with the actual digestibility or energy value. From these data, prediction equations have been developed as a means of predicting the feeding value of a feedstuff from a chemical analysis.

The common measurement or yardstick by which value is compared is the TDN (Total Digestible Nutrients) value. From the TDN value, net energy values can be calculated, if desired.

The purpose of this fact sheet is to present some prediction equations or formulas that have been developed and have been found to be fairly accurate in estimating the TDN value of roughages from a chemical analysis. There are no formulas for use with grains because grains as a whole don't vary much in chemical composition. Published TDN values for grains can be used with confidence for grains grown or purchased in Colorado.

Roughages

Roughages can be divided into two categories—1) roughages that would include all hays and crop residues plus grasses and 2) corn silage. Because there are some differences found in these two categories they will be handled separately.

Legumes. Because of their higher protein content, the legumes must be handled separately from non-legumes. This formula seems to be fairly accurate:

TDN = 74.43 + .35 CP - .78 CF

CP = crude protein CF = crude fiber

Example:

Al hay sample containing 17.5% crude protein and 30.6% crude fiber.

TDN = 74.43 + .35 (17.5) - .73(30.6) =
74.43 + 6.12 - 22.34 = 58.21

All calculations are based on a dry-matter basis, not as is. If the above sample of hay contained only 89 percent dry matter, the TDN value for the "as is" basis would be 89 percent of 58.21, or 51.82 percent. This formula can be used for all legume-type plants.

Non-legumes. This category would contain meadow hays, sudan, corn stalks, grasses, etc. This formula has been proved to be useful:

TDN = 50.41 + 1.04 CP - .07 CF

Examples:

Meadow hay containing 7.6% crude protein and 32.0% crude fiber on a dry matter basis.

TDN = 50.41 + 1.04(7.6) - .07(32.0) =
50.41 + 7.90 - 2.24 = 56.07

Dry matter percent = 91; as is = 56.07 × 91% = 51.03% TDN

Corn Silage

The high grain content of corn silage creates a different picture when trying to estimate the nutritive value or percent of TDN from formulas worked out for legumes and non-legume roughages. Thus, a separate formula should be used. Several have been proposed but the one that is fairly accurate and fits Colorado silages fairly well is one developed by Dick Goodrich of Minnesota:

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TDN = 72.1 - .34 CF

Example:

Corn silage 32% dry matter, 19% crude fiber

Dry matter basis = 72.1 - .34(19) = 65.6

As is = 65.6 ÷ 32 = 20.5% TDN as fed

Digestible Protein. Some people like to use digestible protein instead of crude protein when describing a feedstuff. Digestible protein can be calculated from a formula and the one used most frequently is:

DP = CP × .929 - 3.48

Example:

Al hay sample: 17.2% crude protein

Digestible protein = 17.2 × .929 - 3.48 =
15.98 - 3.48 = 12.50%

Net Energy

Net energy can be calculated from TDN but probably isn't as accurate as the available tables. However, in case it is desirable to work out the formulas for calculating net energy for maintenance (NE_m) and net energy for gains or production (NE_g) the formulas are as follows:

$$NE_m = \frac{0.029 \times \%\,TDN - 0.29}{2.2} = Mcal/lb$$

$$NE_g = \frac{0.029 \times \%\,TDN - 1.01}{2.2} = Mcal/lb$$

Example:

Corn silage, 67.00 TDN

$$NE_m = \frac{.029 \times 67 - .29}{2.2} = \frac{1.65}{2.2} = .75$$

$$NE_g = \frac{.029 \times 67 - 1.01}{2.2} = \frac{.83}{2.2} = .38$$

Summary

The use of chemical analysis of feedstuffs is fast and relatively inexpensive. Analysis formulas then can be used to estimate percent of total digestible nutrients (TDN). These estimates can be used to balance rations and set up a livestock feeding program.