Understanding Feed Test Analysis Terms

The key to accurate feed tests is correct sampling of your forages and grains. Equally important, is understanding what the terms on your feed test report mean. This publication will explain terms that may appear on your feed test reports, depending upon which feed testing laboratory you use and the type of nutrient analysis you request.

Moisture and Dry Matter Content

**Dry Matter (DM)** is the percentage of a feed that is not water. It includes all of the ingredients including protein, fat, fibre, minerals and vitamins but not the water.

**Moisture** percent is a measurement that tells you the amount of water in the feed sample. Percent moisture plus percent DM always equals 100. If you know the moisture content of your feed you can calculate the % DM as:

\[ DM = 100 - \% \text{ Moisture} \]

When nutritionists formulate rations for your sheep, they use the content of the nutrients on a dry basis.

Dry verses As Fed Basis

If you examine the sample feed test report (Table 2) you can see that the nutrient contents of the feeds are reported on both a “dry” and an “as fed” basis. As fed refers to the nutrient content of a feed when it is fed to your sheep “as is” with the moisture present in the feed. A nutrient expressed on a dry basis refers to the amount of that nutrient in the feed after all the water has been removed by drying the feed sample in an oven. You can convert from an as fed to a dry matter basis using the following formula:

\[ \text{As Fed} = \text{Dry Basis} \times (\% \text{ DM} ÷ 100) \]

Expressing nutrients on a dry basis allows more accurate nutrient comparisons to be made between different feeds. For example, suppose you want to compare the protein content of the haylage (50% DM) and hay (80% DM). On an as fed basis the haylage has 8% protein and the hay has 9.6% protein. It seems that the hay is higher in protein. However, if you compare the protein content on a DM basis the hay is 12% \((9.6 ÷ .80 = 12)\) and the haylage is 16% \((8 ÷ .50 = 16)\). Your sheep will consume more protein per kilogram of dry matter from the haylage then they will from the hay.

Measuring Protein Content

**Crude Protein (CP)** is a measurement of the total nitrogen in the feedstuff. The term crude protein is used because the value includes both nitrogen present as true protein (amino acids) and nitrogen containing substances such as ammonia, urea, nitrates and other compounds. Percent CP does not differentiate between protein that is available or unavailable to your sheep. Protein that is unavailable is bound to the fibre portion of the feed.
### Table 1. Sample Feed Analysis Report

<table>
<thead>
<tr>
<th>Sample Code: Alfalfa Hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client Sample: Description 1&lt;sup&gt;st&lt;/sup&gt; Cut Alfalfa Hay</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis</th>
<th>As Fed Basis</th>
<th>Dry Basis</th>
<th>Analysis</th>
<th>As Fed Basis</th>
<th>Dry Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>19.8</td>
<td>0.0</td>
<td>Calcium (%)</td>
<td>0.92</td>
<td>1.14</td>
</tr>
<tr>
<td>Dry Matter (%)</td>
<td>80.2</td>
<td>100</td>
<td>Phosphorus (%)</td>
<td>0.23</td>
<td>0.28</td>
</tr>
<tr>
<td>Crude Protein (%)</td>
<td>14.2</td>
<td>17.7</td>
<td>Potassium (%)</td>
<td>2.09</td>
<td>2.61</td>
</tr>
<tr>
<td>Available Protein (%)</td>
<td>14.2</td>
<td>17.7</td>
<td>Magnesium (%)</td>
<td>0.32</td>
<td>0.40</td>
</tr>
<tr>
<td>Heat Damaged Protein (%)</td>
<td>1.5</td>
<td>1.8</td>
<td>Sodium (%)</td>
<td>0.08</td>
<td>0.10</td>
</tr>
<tr>
<td>Acid Detergent Fibre (%)</td>
<td>32.0</td>
<td>39.8</td>
<td>Zinc (ppm)</td>
<td>12.9</td>
<td>16.0</td>
</tr>
<tr>
<td>Neutral Detergent Fibre (%)</td>
<td>45.7</td>
<td>56.9</td>
<td>Manganese (ppm)</td>
<td>31.6</td>
<td>39.4</td>
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<tr>
<td>Total Digestible Nutrients (%)</td>
<td>46.4</td>
<td>57.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digestible Energy (Mcal/kg)</td>
<td>2.0</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Measuring Heat – Damaged Protein**

Heating causes a chemical reaction between the protein and carbohydrates present in the feed. This process changes the protein so that it becomes bound to the fibre and indigestible or unavailable for use by your sheep. Different feed testing labs use different terms to describe the amount of bound or heat-damaged protein in your forages.

**Acid Detergent Insoluble Nitrogen (ADIN)** is the percentage of nitrogen bound to the fibre portion of the feed and is not digested by the animal or rumen bacteria. The higher the ADIN value the greater the amount of heat damage. Your feed test report may refer to this as Acid Detergent Fibre–Nitrogen (ADF–N).

Instead of measuring the amount of nitrogen bound to the fibre, some feed testing laboratories estimate the amount of crude protein bound to the fibre fraction of the feed. Therefore, on your feed test report, the words Acid Detergent Insoluble Protein (ADIP) or Acid Detergent Insoluble
Crude Protein (AD–ICP) or Acid Detergent Fibre–Crude Protein (ADF–CP) may appear. All of these terms are used to estimate the amount of heat-damaged protein.

If you suspect that your feeds have been heat damaged, call your local feed testing laboratory to discuss what analysis are available to determine the extent of the heat damage. If excessive heat damage has occurred then the available or adjusted crude protein value should be used to formulate rations for your sheep.

**Adjusted Crude Protein (ACP) or Available Protein** is a calculated protein value corrected for heat damage. It is the portion of protein that is not bound to the fibre and is available for use by the animal. When an analysis for heat damage has not been requested, the percent crude protein and the percent adjusted or available crude protein will be the same value on your feed test report.

**Measuring Fibre Content**

Forage plants are made up of cells containing highly digestible compounds and fibrous cell walls, which provide support. The cell wall fibre has three components cellulose, hemicellulose and lignin. Your sheep can partially digest the cellulose and hemicellulose component because the microorganisms in the rumen can break down the fibre to provide energy. Lignin however, is non-digestible. Mature forages have a lower proportion of leaves a higher proportion of stem material compared to younger forages. Stems contain more fibre than the leaves and are therefore less digestible. The more digestible the forage is the more energy an animal can get out of it. Feed testing laboratories usually use two tests for determining the fibre content of your feed.

**Acid Detergent Fibre (ADF)** is a measure of the cell wall components cellulose and lignin. As the lignin component increases with maturity, ADF increases and the digestibility, and quality of the forage decreases. At the same stage of maturity, legumes have a lower ADF content than grasses. An ADF content of less than 30% on a DM basis is an indication that the forage is high quality. The energy content of forages is calculated from the ADF value.

**Neutral Detergent Fibre (NDF)** is a measure of the hemicellulose, cellulose and lignin content. NDF is used to predict feed intake in ruminants. As plants mature the stem becomes more fibrous largely due to increasing lignin content and the NDF levels increase. A low NDF level is desirable since the lower the NDF value the more of the forage your sheep will potentially eat. A general rule of thumb is that high quality hay should have an analysis of 20 crude protein, less than 30% ADF and less than 40% NDF.

**Estimating Energy Content**

The amount of energy in a feedstuff cannot be directly measured and must be calculated using equations based on the ADF content of the feed sample. There are different equations for each species or type of forage. For sheep the energy content of a feedstuff is expressed as total digestible nutrients (TDN) or digestible energy (DE) basis. Net Energy of Lactation (NE₇), Net Energy of Maintenance (NE₀), or Net Energy of Gain (NE₉).
**Percent Total Digestible Nutrients (TDN)** is the percentage of the total digestible protein, fat (x 2.25), non-soluble carbohydrates and NDF fibre in a feed. TDN is a calculation based on the ADF content of the feed. A TDN value of less than 50% indicates that the forage is of poor quality.

**Digestible Energy** is the amount of energy that is available to your sheep. It is measured as the difference between gross energy (the total amount of energy in a feedstuff) and the energy loss in the animal’s feces. Gross energy is determined by measuring the amount of heat produced when a sample of feed is completely burned in a bomb calorimeter in a laboratory.

**Minerals**

The majority of minerals can be analyzed in feed testing laboratories. However only calcium (Ca), phosphorous (P), potassium (K) and magnesium (Mg) are routinely tested since they are extremely variable in forages. On your feed test reports the mineral content may be expressed as a percentage, in grams (gm), milligrams per kilogram (mg/kg) or parts per million (ppm).

**Other Items**

**pH** measures the degree of acidity (pH less than 7) or alkalinity (pH greater than 7) of a substance. Feed pH measures the acidity of fermented feeds such as silages or haylages. Silages with 60 to 75% moisture should have a pH below 4.5.

**Non-structural carbohydrates (NSC)** also referred to, as non-fibre carbohydrates are the parts of the plant that provide energy to an animal and are stored within the plant cell wall. The most common types of NSC are sugars in forages and starches in grains. NSC is used to formulate dairy rations.

**Relative Feeding Value** is an index used to rank the quality of forages based on digestibility and intake potential. It is based on ADF and NDF levels and is used for marketing feeds and when comparing legume and legume/grass forages. It is not used in balancing rations for animals. The higher the RFV the better the quality of forage with an RFV or 100 being considered an average value. The RFV of grasses is usually lower than that of mixed or legume forages.

**Dry Matter Intake (DMI)** is an estimate of the amount of forage an animal will eat and is determined from the NDF content.

**Digestible Dry Matter (DDM)** is an estimate of the percentage of the forage that is digestible. It is based on feeding trails and is determined from the ADF content.

The following nutrient analyses are available but the calculations are for dairy or beef cattle.

**Net Energy of Gain** is an estimate of the amount of feed energy used for body weight gain above that required for maintenance.

**Net Energy of Lactation** is the amount of energy from the feed that will support an animal’s needs for maintenance plus milk production. It is used in formulating rations for dairy cattle.
Net Energy of Maintenance is the amount of energy required to maintain an animal with no change in body weight or body composition. It is based on ADF.

Talk to your feed testing laboratory about the nutrient analysis packages that are available and what you nutrients you should be testing for.

References


Nutrition Questions?
Contact: Dr. S Markus, Alberta Ag-Info Centre, 1-866-882-7677